CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM

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BY

DR. AMTOJ SINGH

SUPERVISOR

DR. HARPAL SINGH SELHI

DEPARTMENT OF ORTHOPAEDICS

DAYANAND MEDICAL COLLEGE AND HOSPITAL

LUDHIANA

(MAY 2020)

DECLARATION

I declare that the thesis entitled **"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM"** has been prepared by me under the guidance of **Dr. Harpal Singh Selhi,** Professor, Department of orthopaedics, Dayanand Medical College and Hospital, Ludhiana. No part of this thesis has formed the basis for the award of any degree previously.

_____

Dr. Amtoj Singh
Department of Orthopedics
Dayanand Medical College & Hospital
Tagore Nagar
Ludhiana-141001
Punjab

Date:

CERTIFICATE

I certify that **Dr. Amtoj Singh** has prepared his thesis entitled **"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM"** for the award of degree of M.S. in Orthopaedics of Baba Farid University of Health Sciences, under my guidance. He has carried out the work at the Department of Orthopaedics, Dayanand Medical College & Hospital, Ludhiana.

Supervisor

Dr. Harpal Singh Selhi
Professor
Department of Orthopedics
DMC&H, Ludhiana

Co-Supervisor

Dr. Deepak Jain
Professor
Department of Orthopedics
DMC&H, Ludhiana

Date:

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT AND PRINCIPAL

This is to certify that the thesis entitled **"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM"** is a bonafide research work done by **Dr. Amtoj Singh** under the guidance of **Dr. Harpal Singh Selhi**, Professor, Department of Orthopedics, Dayanand Medical College & Hospital, Ludhiana.

Head of Department **Principal**

Dr. Rajnish Garg
Professor & Head
Department of Orthopedics
DMC&H, Ludhiana

Dr. Sandeep Puri
Principal
DMC&H, Ludhiana

Date:

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Dr. Amtoj Singh
Department of Orthopedics
Dayanand Medical College & Hospital
Tagore Nagar
Ludhiana-141001
Punjab

Date:

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Dedicated

To

My Family

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Dr. Amtoj Singh

ABBREVIATIONS

AVN	Avascular necrosis
CNS	Central nervous system
CT	Computed tomography
HO	Hypertrophic ossification
KL APPROACH	Kocher langenback approach
OA	Osteoarthritis
THR	Total hip replacement

ABSTRACT

Introduction: Transverse acetabulum fractures are debilitating injuries to the patient and challenging for the surgeons to treat. Clinical and radiological outcomes of surgically managed patients of acetabulum fractures have been sparsely studied in India.

Aims and Objectives: To evaluate the hip function of operatively managed transverse acetabular fracture and to assess the complications of operative fixation of transverse acetabular fractures.

Materials and Methods: A prospective review of 20 patients of transverse fractures of acetabulum between January 2017 and May 2019 was performed at Dayanand Medical College and Hospital, Ludhiana. Functional assessment was made using the Merle d'Aubigne and Postel Method.

Results: We had the final follow up of all 20 patients included in the study managed with open reduction and internal fixation of fracture acetabulum. The injuries were more common in males and the younger age group was more commonly affected with roadside accidents being the most common cause. At final follow up, 15 patients [75%] had an excellent score, 3 patients [15%] had good score, 2 patients [10%] had a poor score. 9 patients (45%) had an excellent radiological result at final follow up, 9 patients (45%) had good radiological result, 1 patient (5%) had fair radiological result and 1 patient (5%) had a poor radiological result.

Conclusion: Operative management of transverse fractures of acetabulum results in satisfactory clinical and radiological outcomes despite high incidence of post traumatic arthritis. We recommend that these types of injuries require timely and aggressive emergency resuscitative management followed by fixation by adequately trained pelvi-acetabular surgeons using various methods used in our study.

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INTRODUCTION

Acetabulum fractures remain a big challenge to orthopaedic trauma surgeons for the diagnosis and management. These injuries do not have a specific age distribution. The fractures are potentially a life-threatening condition, typically caused by high energy trauma in younger individuals and associated with multi-system injuries. In some older individuals, pelvic fractures can also occur with trivial low energy falls due to weakening of bones as a sequela of osteoporosis. There is a very high incidence of associated injuries in acetabular fractures such as pelvic ring injuries, chest and abdominal trauma and lower limb fractures.

Incidence of acetabulum fractures is approximately 3 per one lakh individuals. Out of all the types of acetabular fractures, transverse acetabular fracture contributes to 5% to 19% of the total. The transverse fracture is an elementary type fracture of the acetabulum. It consists of a single fracture line that traverses both the anterior and posterior columns of the acetabulum. The fracture line separates the innominate bone into the superior iliac segment and the inferior ischio-pubic segment.

A transverse acetabular fracture is a sagittally oriented fracture that separates the bony pelvis into superior and inferior halves, with the superior component lateral and the inferior component medial at the roof of the acetabulum. The fracture may be elementary (i.e., with no other fracture component involving other portions of the bony pelvis); however, if the fracture also has a coronal component that extends inferiorly and disrupts the obturator ring (splitting the inferior half into anterior and posterior components), then a T-type fracture is present. Alternatively, if there is an additional fracture line that separates the posterior wall of the acetabulum into a separate fragment, then a transverse fracture with a posterior wall fracture is present. For column fractures as well as elementary transverse and T-type transverse fractures, the level of the intra-articular fracture line is clinically important and is defined about its relationship to the cotyloid fossa:

supratectal, juxtatectal, or infratectal. Fractures above the fossa are in the middle of the weight-bearing surface and the femoral head subluxes medially with the displaced column, which is a negative prognosticator for preservation of the native joint. An infratectal fracture is within the cotyloid fossa and the femoral head stays within the intact acetabulum; thus, posttraumatic osteoarthritis develops later in a joint with an infratectal fracture than in one with a supratectal fracture. A juxtatectal fracture occurs through the top of the cotyloid fossa and the joint may or may not develop osteoarthritis.

Earlier, surgical fixation of acetabular fractures was a tedious task as there was limited knowledge of exposure, difficulty in achieving anatomical reduction of the joint and frequent post-operative complications which led to poor functional outcomes. The various factors which affected the functional outcomes were patient dependent factors, type and severity of injury, type of fracture, extent of displacement and commination and any associated multi-system injuries. The primary line of management of acetabular fractures was conservative with closed reduction and skin/skeletal traction. But these methods also failed to achieve and maintain complete anatomical reduction and joint congruity leading to complications like osteoarthritis of the hip joint, avascular necrosis of head of femur and postural/gait disturbances. The development of newer diagnostic tools like MDCT has helped us to minutely analyse the three-dimensional disturbance in the normal anatomy and plan the surgical management accordingly.

A precise understanding of both the injured patient and the acetabular fracture pattern sustained is crucial because the anatomical relationships of the acetabulum are complex and the correct choice of surgical approach to manage the fracture imperative. Although a careful clinical assessment can outline the patient’s general status and the forces that produced the injury, only a complete radiographic examination can reveal the exact nature of the fracture. Together, the patient and fracture factors define the injury personality and lead to logical decision making in treatment.

Following a patient's surgery, managing pain and any immediate and delayed post-operative complications becomes the surgeon's main concern. Initially analgesics are given by the intra-venous route along with the antibiotics. Other medications include the use of anticoagulants to prevent the formation of blood clots and Indomethacin, which prevent bone formation in abnormal areas such as the muscles (heterotopic ossification). Patients are encouraged to get up and move out of the bed with early physiotherapy and rehabilitation as this prevents the onset of a lot of complications. There may also be a residual neurological deficit which is either due to trauma or iatrogenic. Most of the patients regain the function of the limb partially or completely by six to eighteen months of post-operative period.

With advances in general trauma management, treatment of acetabular fractures has also evolved reducing the mortality and morbidity earlier associated with these fractures.

In the present era, surgery has become the treatment of choice for management of transverse fractures of acetabulum as accurate anatomical reduction and adequate internal fixation can be attained. These fractures can be fixed with anterior column plating only, posterior column plating only, anterior column plating combined with posterior column screw fixation, posterior column plating and anterior column screw fixation or bi-columnar plating depending upon the nature and severity of the fracture. It helps in early pain relief, early mobilization and fracture union as compared to conservative treatment. But these are associated with complications such as infection, haemorrhage, iatrogenic nerve injuries, deep vein thrombosis, heterotrophic ossification. Despite these complications, we can achieve the reduction of fracture with less than 2 mm displacement. This decreases the incidence of post traumatic osteoarthritis of the hip joint.

Transverse fractures of acetabulum are one of the most difficult fractures to treat in the field of orthopaedic surgery. Complete anatomical reduction is required to achieve optimal functional outcomes. This in turn requires a highly skilled surgeon with a

substantial experience in dealing with acetabular fracture surgeries, along with a skilled anaesthetic team with can competently deal with any intra operative or post-operative complications. Newer techniques for management of transverse and complex acetabular fractures have evolved in the last few years only. Limited literature is available regarding these types of fractures. The aim of the present study is to determine the clinical and radiological outcomes of transverse fractures of acetabulum.

AIMS AND OBJECTIVES

1. To evaluate the hip function of operatively managed transverse acetabular fracture.
2. To evaluate reduction on radiology.
3. To study the complications of operative fixation of transverse acetabular fractures**.**

REVIEW OF LITERATURE

Historically, Acetabular fractures are relatively uncommon injury. The severity of these injuries is demonstrated by the fact that early descriptions of acetabular fractures are the results of autopsy findings of patients who had sustained significant trauma.

Incidence of acetabulum fractures is approximately 3 per one lakh individuals. Out of all the types of acetabular fractures, transverse acetabular fracture contributes to 5% to 19% of the total. The transverse fracture is an elementary type fracture of the acetabulum. It consists of a single fracture line that traverses both the anterior and posterior columns of the acetabulum. The fracture line separates the innominate bone into the superior iliac segment and the inferior ischio-pubic segment.

The pelvis is the central part of the skeletal system and consists of two innominate bones on either side and the sacrum which are firmly connected anteriorly and posteriorly forming a complete ring. The acetabulum lies on the lateral surface of the pelvic bone in the region where the ilium, ischium and pubis meet and articulates with the head of femur. It is a very strong mechanical construction supported by various ligaments and muscles and can withstand very high amount of energy and forces transmitted through the pelvis.

The acetabulum is a complex anatomical structure which is formed from 6 fundamental components:

1. Anterior column
2. Posterior column
3. Anterior wall
4. Posterior wall
5. Medial wall
6. Acetabular dome

The acetabulum is supported by the anterior (blue) and posterior columns. The dome of acetabulum lies in the concavity of the arch (Judet et al).

The anterior column is formed from a combination of the ilium and pubic bones. It extends from the posterosuperior ilium down along the pelvic brim to the pubic tubercle. Its width laterally extends to the ASIS. The underside of the anterior arch supports the anterior wall of the acetabulum. [1]

The posterior column is composed of thick, dense bone and forms a wedge shape in the transverse plane. Extending from superior to the greater sciatic notch to the ischial tuberosity, it is through this column that the greater and lesser sciatic notches are stabilized via tension trusses, the sacrospinous, and sacro-tuberous ligaments. Anterolaterally, the column supports the posterior half of the acetabular articular surface. Medial to the posterior column is the quadrilateral plate. The posterior wall extends laterally from this structure. [1]

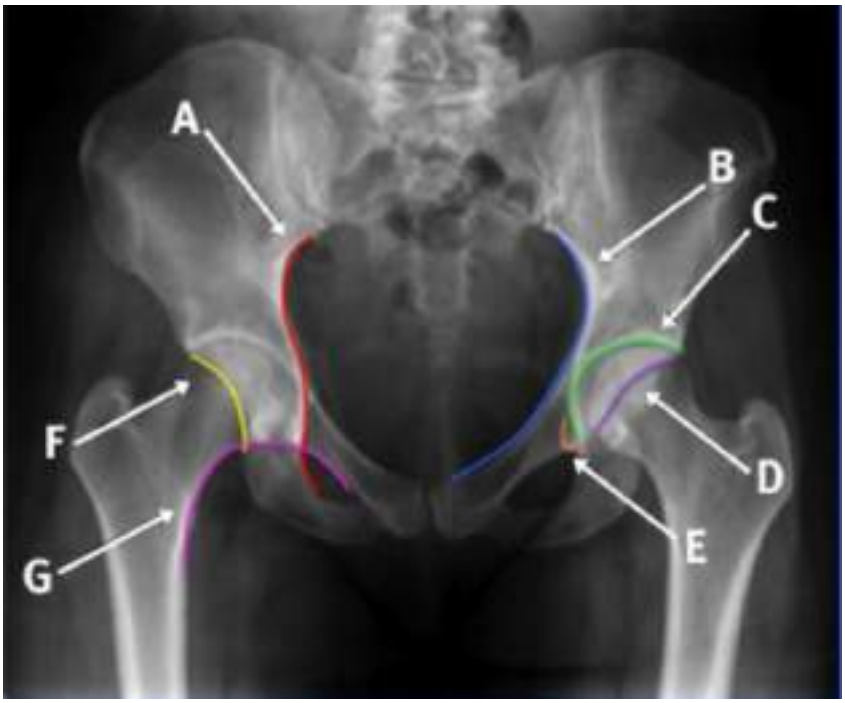
The acetabular socket itself is formed by the anterior wall, the posterior wall, the dome, and the medial wall. The anterior wall is directly connected to the pubis, and the superior pubic ramus extends anteriorly from its medial border. The anterior wall and anterior rim of the acetabulum have a variable morphology. Proceeding medially along the anterior wall, there is an indentation in the anterior wall adjacent to a prominent groove on the pelvic rim. This groove, just lateral to the iliopectineal eminence, provides a track for the iliopsoas. The iliopectineal eminence lies just anterior to the inferior half of the anterior wall on the pubic brim. [1]

The posterior wall is larger and projects more laterally than the anterior wall. Its lateral edge has a nearly vertical but slightly curved route. The posterior wall is the most vulnerable portion of the acetabular structure, lying farthest from the support of the arch of the two columns. It is the most commonly and easily fractured, and the most important for stability. [1]

The medial wall includes the fossa of the acetabulum laterally and the quadrilateral plate medially. The fossa is a central cavity where no articulation occurs, and it is filled with a fat pad (called the pulvinar) and the ligamentum capitis femoris. [1]

Radiographically, [2] six landmarks on the antero-posterior views are identifiable for description of the type of acetabular fractures:

1. Iliopubic line
2. Ilioischial line
3. Teardrop
4. Sourcil
5. Anterior lip
6. Posterior lip



Picture 1 A. Ilioischial line, B. Iliopectineal line, C. Dome, D. Anterior wall, E. Teardrop, F. Posterior wall, G. Shenton's line

Disruption of any of these radiographic landmarks suggests a fracture of the underlying structure. While the iliopubic line corresponds to the medial cortical border of the anterior column, the ilioischial line corresponds to the medial cortical border of the posterior column. The teardrop outlines an anterior portion of the quadrilateral plate medially, and an anteroinferior portion of the acetabular fossa laterally. This radiographic landmark identifies the position of the medial wall of the acetabulum. The Sourcil represents the superior most portion of the acetabular dome. The anterior and posterior lips represent the lateral most cortical border of the anterior and posterior acetabular walls. [2]

Mechanism of Injury

Acetabular fractures occur as force is transmitted from the femur to the pelvis via the femoral head. The fracture pattern, therefore, is dependent on the

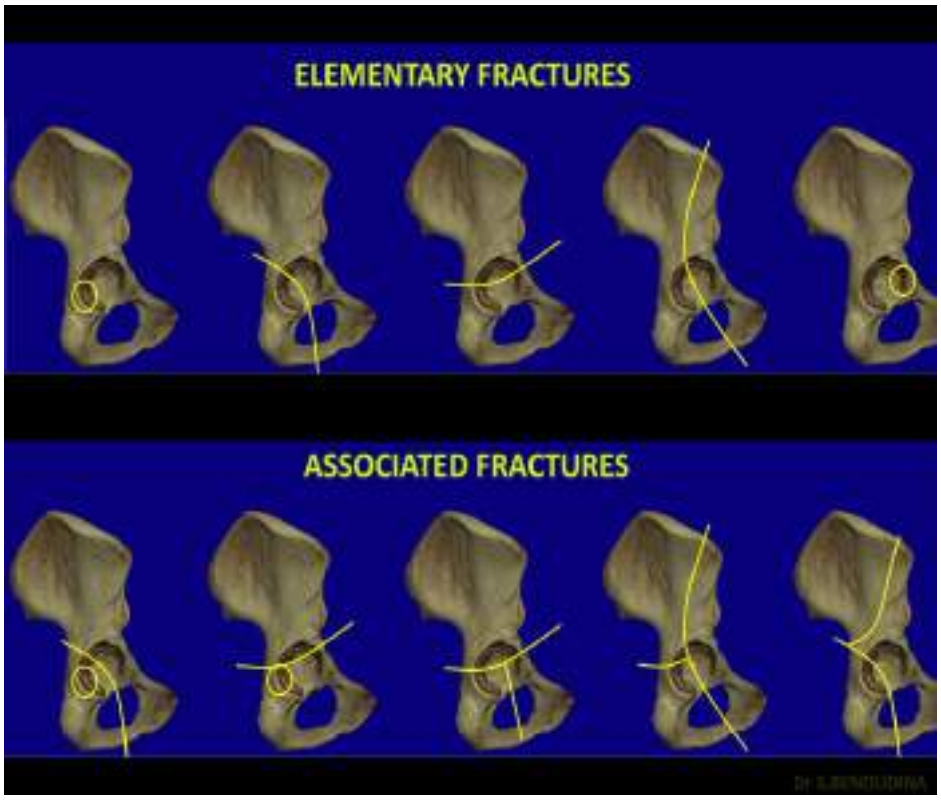
- Position of the hip at the time of injury,
- Direction of force and
- Magnitude of the impact.

The magnitude of displacement as well as the comminution or degree of articular impaction depends on the magnitude of the force applied as well as the strength of the bone it is applied to. A relatively low-energy injury may produce a severely comminuted fracture in an osteoporotic patient.

Classification of acetabular fractures [Letournel and Judet classification]

This classification has 10 distinct categories which are divided into five elementary types and five associated types the five elementary fracture patterns are the anterior wall, anterior column, posterior wall, posterior column, and transverse. The elementary fracture patterns are defined as those fractures that separate all or part of a single column of the acetabulum. The anterior and posterior column fractures separate the entire column from the intact innominate; whereas the anterior and posterior wall fractures separate only that portion of the column’s articular surface. The transverse fracture pattern consists of a single

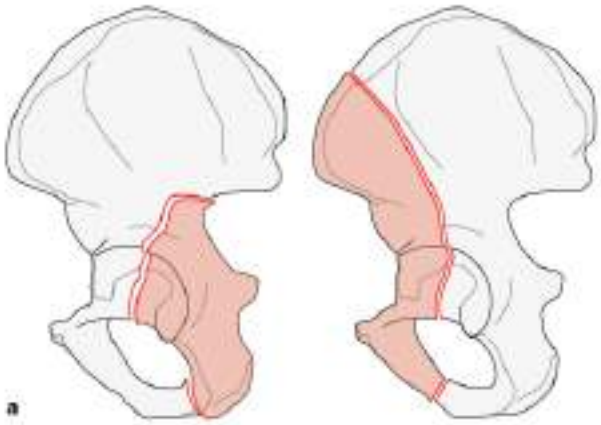
fracture line that traverses both the anterior and posterior columns of the acetabulum. This fracture is included as elementary because of the fundamental nature of the fracture pattern. The associated patterns are either a combination of elementary patterns or an elementary pattern with an additional fracture component. The five associated fracture patterns are the posterior column and posterior wall, anterior column or wall and posterior hemi transverse, transverse and posterior wall, T-shaped, and both column fracture.[3]



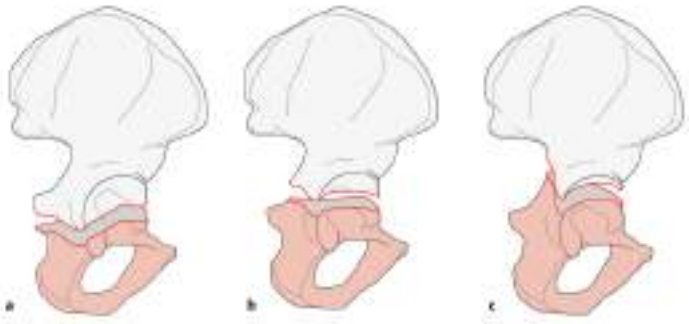
Picture 2. Classification of acetabular fractures [Letournel and Judet classification]

COMPREHENSIVE CLASSIFICATION: ACETABULAR FRACTURES [4]

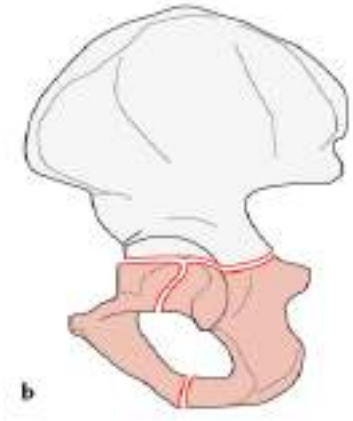
- Type A: Partial articular fractures, one column
  - A1 Posterior wall fracture
  - A2 Posterior column fracture
  - A3 Anterior wall or anterior column fracture

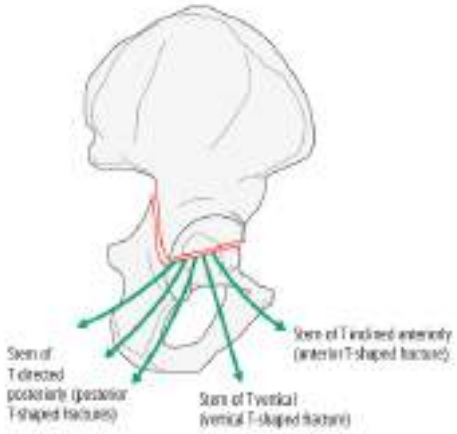


- Type B: Partial articular fractures, transverse
    - B1 Transverse fracture
    - B2 T-shaped fracture
    - B3 Anterior column and posterior hemi-transverse fracture



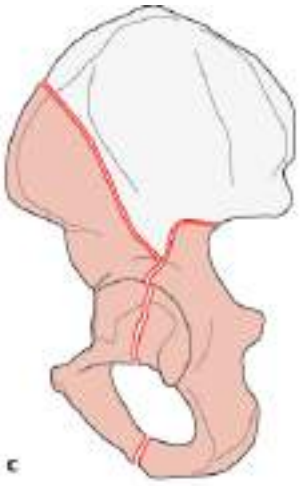
Infratectal below or through the cotyloid fossa, b. Juxtatectal through the top of cotyloid fossa, c. Transtectal through the superior weight bearing surface





Possible Directions of stem in a T-shaped Fracture

- Type C: Complete articular fractures, both columns
  - C1 High
  - C2 Low
  - C3 Involving sacroiliac joint



CT SCAN

CT scan helps in identification of fracture lines not visualized by radiographs. Orientation of fracture line, vertical portion of T-type acetabular fracture and rotation of fracture fragments are well made out. CT Scan may give additional information regarding

- Intra-articular loose fragments
- Marginal impacted fragment
- Degree of fracture comminution
- Position of the femoral head
- Femoral head lesions
- Joint Congruence
- Sacroiliac joint and the posterior pelvic ring

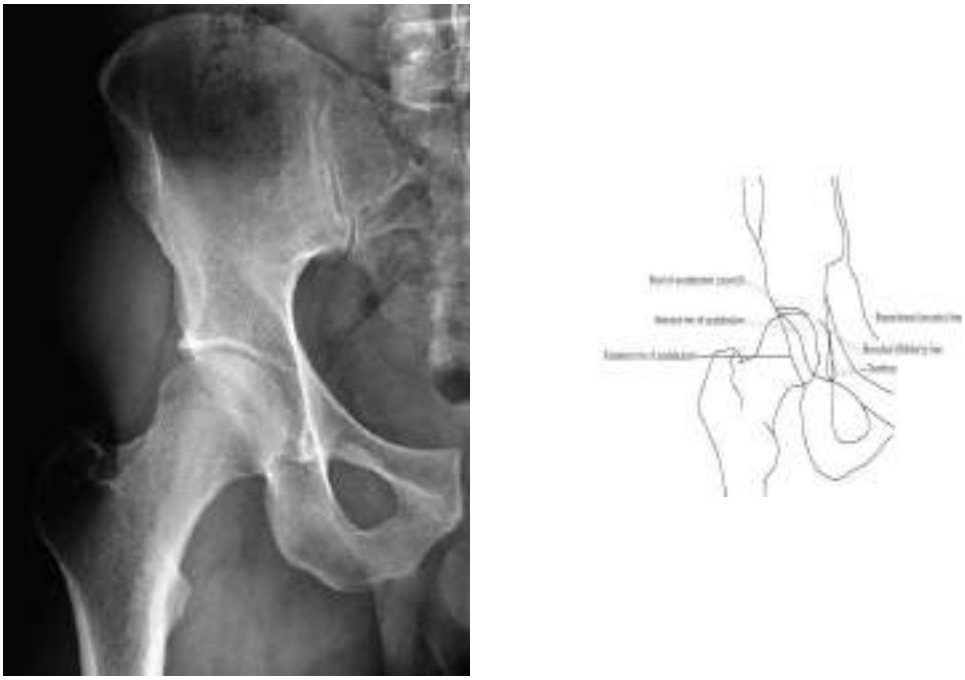
3-D CT SCAN

It is converted from 2-dimensional CT scan data. 3D CT allows for subtraction of femur and varying degree of rotation of pelvis which provide a good overall picture of the fracture configuration.

Yang et al., in their research on mapping of both column acetabular fractures with three-dimensional computed tomography and implications on surgical management stated that Surgically treated both-column fractures displayed very common patterns. The most common pattern was the low anterior column fracture in nearly two thirds of cases, the high anterior column fracture in three fifths of cases and the posterior column fracture with posterior wall involvement in nearly two fifths of cases. Most both-column fractures (56%) were managed through combined Ilioinguinal and Kocher-Langenback (IL + KL) approaches. According to the reduction categories described by Matta, anatomical reduction was achieved in 45 patients (63%), imperfect reduction in fourteen (20%), and poor reduction in twelve (17%). In conclusion, the fracture maps of both-column fractures derived from 3D CT scan aid in guiding the treatment of such complex fractures, in terms of surgical approaches, preoperative planning, and implant strategy. [5]

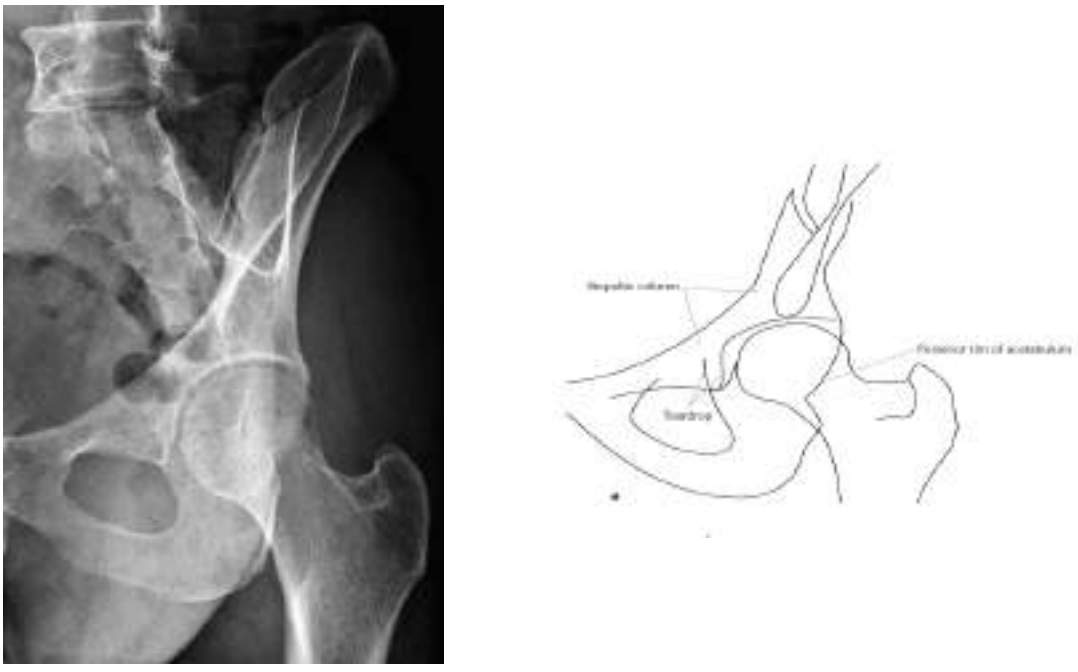
From a historical perspective, the literature from the 1950s and 1960s offered conflicting recommendations regarding the optimal care for a fracture of the acetabulum. Both nonoperative and operative treatment regimens were purported to be the best. Both nonoperative and operative treatment regimens were purported to be the best. However, much of the confusion in management recommendations can be attributed to the fact that there was no comprehensive or accepted acetabular fracture classification, an unsatisfactory situation that was well recognized even at that time. [6,7]

Judet et al., provided more clarity to this confused situation. In their 1964 treatise, they set out to describe, among other things, the radiographic findings in acetabular fracture patients and to outline a plan of treatment. This manuscript describes the use of the AP and two 45* oblique views of the pelvis to evaluate the acetabular fractures. These radiographic views, now known as —Judet views, named after the author, include the obturator view, and the iliac oblique view. These are now the standard radiographic films used for evaluation of acetabular fractures. Their recommendation for operative treatment was based on 10 years of study and resulted from their disappointment with the results of nonoperative methods. Over the next three decades, they refined several aspects presented in this seminal publication. However, the basic concepts remain, including understanding the surgical anatomy of the innominate bone, defining the injury via appropriate radiographic assessment, and, by these means, determining a suitable treatment plan. [8]



Picture 3 Standard AP x-ray of a right hip

(modified from Judet et al)



Picture 4 Obturator or three quadrant internal oblique view of the right hip (modified from Judet et al)

Picture 5 Iliac or 3 quarter oblique view of a right hip (modified from Judet et al)

The further studies by Letournel and Judet and by Matta have shown that to attain the best results, hip joint congruity and stability must be accompanied by an anatomic (defined as less than 2 mm of residual displacement) reduction of the displaced articular surface. Therefore, accurate reduction of the intra-articular fracture fragments is critical for a successful outcome, as is maintenance of this reduction by internal fixation. It has been stressed that in a displaced fracture this anatomic reduction is very difficult to obtain by closed means. The work of Judet and Letournel began the changes which led to the management of displaced fractures of the acetabulum by operation rather than conservatively. They recognised that the principles applied to the treatment of displaced articular fractures should also be applied to the acetabulum. Subsequently, open anatomical reduction of the articular surface combined with rigid internal fixation and early mobilisation became the standard treatment for these injuries. This approach led to a reduction in the incidence of post-traumatic arthritis and an improvement in the overall outcome. However, certain of these fractures require extensile approaches and complications such as the extensive formation of haematoma, local or systemic infection,

iatrogenic nerve injury and heterotopic bone formation have been described. [9,10]

Computed tomography was introduced in 1980 and was a substantial development in the diagnosis and treatment of acetabular fractures. In 1984, Letournel held his first international course on treatment of fractures of the pelvis and acetabulum in Paris. Letournel advocated an approach or protocol to treatment of acetabular fractures that includes extensive study of the X-rays to understand the anatomy of the fracture pattern and subsequent correct classification followed by appropriate operative positioning of the patient whenever possible to operate the fracture through a single surgical approach. Emphasis has been placed on obtaining anatomic reduction of the articular surface. Long-term clinical outcome data suggest that the more accurate the articular reduction, more is the clinical outcome.

Giannoudis, et al conducted a study showing how it is important, at operation, to obtain the most accurate reduction of the fracture, which is possible, with a minimal surgical approach, as both influence the outcome. A total of 3670 patients were selected and followed for the study that satisfied their inclusion criteria. The association of extremity fractures and head injuries with the morbidity in these patients was studied. The most frequent type of fracture encountered in the study was the fracture of posterior wall (23.9%), followed by bi-columnar fractures (22%), anterior column fractures (3.9%), and transverse fractures (5%). The approaches used for fixation of these fractures were Kocher-Langenback approach (48.7% of cases), Ilio-inguinal approach (21.9%) and Ilio-femoral approach (12.4%). [11]

Open reduction and internal fixation of transverse fracture acetabulum has a good functional outcome as compared to conservative management. All fixation systems enhance biomechanical stability significantly. Anterior column plate combined with quadrilateral area screws has quite comparable results to double column plates, they were superior to anterior column plate combined with posterior screws.

Dong, et al conducted a study on the biomechanical stability of the common fixation systems used for acetabulum fractures and concluded

that applying open reduction and internal fixation in the treatment of displaced complex acetabular fractures has a satisfying therapeutic effect. Time to reduce hip dislocation, quality of fracture reduction as well as traumatic arthritis are independent risk factors affecting postoperative functional outcomes. A finite element (FE) pelvic model with anterior column and posterior hemi-transverse acetabular fractures was created. Three common fixation systems were used to fix the posterior wall acetabular fractures: 1. Anterior column plate combined with posterior column screws (group I), 2. Anterior column plate combined with quadrilateral area screws (group II) and 3. Double-column plates (group III). And 600 N, representing the body weight, was loaded on the upper surface of the sacrum to simulate the double-limb stance. The amounts of total and relative displacements were compared between the groups. [12]

Once established that the operative fixation of acetabular fractures provided better functional outcomes than conservative management, risks and benefits of all the procedures to fix the acetabulum were studied.

Erem et al., in their study on effects of the incision preference in acetabular surgery on the post-operative functional outcomes observed that Incision type and number of incisions must be determined based on the fracture type and fracture localization for better functional outcomes. Forty-seven adult patients who had undergone acetabular surgery and had been followed up for at least 1 year in our clinic were included in the study. Demographic data, trauma type, acetabular fracture type based on the Judet ve Letournel classification, presence of any additional traumatic fractures, time to surgery, operation duration, surgical technique, and postoperative complications were recorded. Range of motion measurements, SF-36 and Harris Hip function scale score, and full weight-bearing times were evaluated on the postoperative first year follow-up and reviewed retrospectively. The study suggested that use of double incisions in the surgery of associated fractures shortens the full weight-bearing time. The

localization and the number of incisions were found to be unrelated with the Harris Functional Hip scale, SF-36 (PCS, physical component score), and SF-36 (mental component score, MCS) scores. The factors that have the most effects on the functional outcomes are the type and the localization. In associated fractures, performing multiple incisions reduces the time for full weight bearing and enables patients to return to their daily routine early but have no effect on the functional outcomes. [13]

Magu, et al observed that modified K-L approach may be a good alternative for the standard K-L approach in the management of elementary fractures and associated fractures of the acetabulum when combined with an anterior surgical approach. The authors concluded that modified K-L approach made the procedure less invasive, shortened the operative time, minimized the blood loss and overcame the exhaustion and fatigue of the surgical team. [14]

Stein Ovre et al., in their study on Differences between fractures with a large posterior-superior fragment and the inverse T-fracture submitted that open reduction and internal fixation of inverse T-fractures and transverse fractures with a floating dome require different surgical approaches. The latter can be treated through a single approach alone, while the inverse T-fracture may require extensile or combined approaches for adequate reduction and fixation. Among the 449 fractures in 443 patients during the inclusion period, 10 fractures (2.2%) were classified according Judet/Letournel as transverse fractures with a secondary vertical fracture line. 6 fractures were classified as inverse T-fractures and 4 fractures were classified as transverse fractures with a floating dome (large posterior-superior fragment). In addition to the 6 inverse T-fractures, there were 4 fractures classified as transverse fractures with a large posterior-superior fragment extending to the iliac crest in accordance with the Judet/ Letournel classification. [15]

Paksay AE et al., in their study on outcomes of surgical management of acetabular fractures treated with anterior approaches concluded that Anterior surgical approaches provide satisfactory outcomes in

appropriate fracture types. Posterior approach can be combined in certain fracture types. Eleven (30%) fractures were simple type and 26 (70%) were mixed type. Two (18%) of the simple fractures were transverse and 9(82%) were anterior column fractures. Fourteen (54%) of the mixed type fractures were both column fractures, 5 (19%) were transverse+posterior wall, 5 (19%) were T shaped and 2 (8%) were anterior column+posterior hemi transverse fractures. Surgical approach was ilioinguinal in 15 (43%) patients, Stoppa in 9 (26%) and combined11 (31%). Our functional outcomes were perfect in 10 (27%) hips, good in 20 (54%), moderate in 4 (10%) and poor in 3 (8%). Our radiological results were perfect in 15 (40.5%) hips, good in 15 (40.5%), moderate in 4 (11%) and poor in 3 (8%). [16]

Bogdan et. al, conducted a study on Surgical Approach Algorithm for Transverse Posterior Wall Fractures Aids in Reduction Quality. A retrospective study was conducted in which patients were drawn from an existing database. The inclusion criterion was transverse posterior wall fractures with adequate imaging treated by one surgeon. All but one patient was treated within 2 weeks of injury. Mean follow-up was 23 months (range, 3 months to 11 years). Between November 5, 1999, and August 22, 2012, 74 patients were treated with open reduction internal fixation for this injury; nine were excluded as a result of percutaneous treatment or inadequate preoperative imaging. The remaining 65 patients (88%) comprised the study group. All patients were treated by the senior surgeon with an algorithm that consisted of either a Kocher–Langenback or sequential approach based on the location, magnitude, and direction of displacement of the ischiopubic segment. Indomethacin was prescribed to all patients for heterotopic ossification prophylaxis for a total of 6 weeks postoperatively.

Based on the algorithm, 82% (53 patients) were treated with Kocher–Langenback and 18% (12 patients) with the sequential approach. Adequacy of reduction was measured using AP and Judet views of the pelvis; union was determined empirically by pain-free weight bearing and lack of displacement over time. Outcomes were the Merle

d’Aubigné score and radiographic findings of avascular necrosis or arthrosis. [17]

Iqbal et al., in their study on Functional and Radiological Outcome of Surgical Management of Acetabular Fractures in Tertiary Care Hospital Study results indicated that mechanism of injury, time between injury and surgery, initial degree of displacement and quality of reduction had significant effect on functional as well as radiological outcome. With the availability of good imaging facilities, surgeon experience, better instrumentation along with good perioperative care, we believe that the surgical fixation of displaced acetabular fractures would yield better results. [18]

Lichte et al., in their study on predictors of poor outcomes of transverse acetabular fractures established that anatomical reduction appears to be an important parameter for a good clinical outcome in patients with both column acetabular fractures. Additional fracture characteristics such as the initial displacement and intra-articular fragments seem to influence the results. Patients should also be advised that both column acetabular fractures with more than two additional associated factors have a significantly higher risk of joint degeneration. A retrospective cohort study in patients with both column acetabular fractures treated over a 30-year period was performed. Patients with a follow-up of more than two years were invited for a clinical and radiological examination. Displacement was analysed on initial and postoperative radiographs. Contusion and impaction of the femoral head was grouped. Injuries of the acetabular joint surface consisting of impaction, contusion and comminution were recorded. The Merle d’Aubigné Score was documented and radiographs were analysed for arthritis (Helfet classification), femoral head avascular necrosis (Ficat/Arlet classification) and heterotopic ossifications (Brooker classification). 115 patients were included in the follow up examination. Anatomic reduction (malreduction ≤ 1mm) was associated with a significantly better clinical outcome than non-anatomical reduction ($p = 0.001$). Initial displacement of more than 10mm ($p = 0.031$) and initial intra-articular fragments ($p = 0.041$) were associated with worse outcome.

Other associated injuries, such as the presence of a femoral head dislocation, femoral head injuries and injuries to the acetabular joint surface showed no significant difference in outcome individually, but in fractures with more than two associated local injuries the risk for joint degeneration was significant higher ($p < 0.001$) than in cases with less than two of them. In the subgroup of anatomically reconstructed fractures no significant influence of the analysed cofactors could be observed. [19]

Jianyin et al, in their study on biomechanical analysis of fixation of anterior column and posterior hemi-transverse fractures concluded that all fixation systems enhance biomechanical stability significantly. Anterior column plate combined with quadrilateral area screws has quite comparable results to double column plates, they were superior to anterior column plate combined with posterior screws. A finite element (FE) pelvic model with anterior column and posterior hemi-transverse acetabular fractures was created. Three common fixation systems were used to fix the posterior wall acetabular fractures: 1. Anterior column plate combined with posterior column screws (group I), 2. Anterior column plate combined with quadrilateral area screws (group II) and 3. Double-column plates (group III). And 600 N, representing the body weight, was loaded on the upper surface of the sacrum to simulate the double-limb stance. The amounts of total and relative displacements were compared between the groups. The total amount of displacement was 2.76 mm in group II, 2.81 mm in group III, and 2.83 mm in group I. The amount of relative displacement was 0.0078 mm in group II, 0.0093 mm in group III and 0.014 mm in group I. [20]

Fahmy et al, in their study comparing single vs double column fixation of transverse fractures of acetabulum inferred that single poster column fixation showed similar result to double column fixation, in terms of fracture stability in follow up period, quality of reduction and early functional outcome. Thirty patients were randomized to one of two groups, either posterior fixation alone (single column group), or posterior plating and anterior fixation with percutaneous anterior

column screw (double column group). Patients were followed up with serial radiographic assessments documenting any loss of reduction, utilizing Matta's radiological criteria, measuring the roof arc angles and by measuring any change in the femoral head offset. Fifteen patients were randomized to each group. Mean patient age was 31 years, mean follow up period was 19 months (range 12-24). There were no significant differences between the two groups with regards the quality of post-operative reduction, blood loss, hospital stay and functional score using the modified Merle d'Aubigné and Postel score. The operative time was significantly longer in the double column fixation group (130 minutes versus 104 minutes). There was no loss of reduction observed in either of the two groups. [16]

Giordano et al., in their study on operative treatment of transverse acetabular fractures suggested that associated transverse-posterior wall acetabular fractures can be managed by a single posterior approach. Direct reduction and fixation of the posterior wall and column components is an adequate option for these injuries. It is not necessary to fix the anterior column component of the transverse fracture. at final follow-up examination 18 to 84 months postoperatively (mean, 46.8 months), the clinical results were considered satisfactory in 31 (88.6%) patients (excellent in nine (25.7%) and good in 22 (62.9%) patients). There was no difference between patients with (n = 15) and without (n = 20) fixation of the transverse anterior component of the acetabular fracture ($p = 0.67$). Radiographic roof-arc angles measured at discharge, at three months postoperatively and at the last follow-up consultation didn't change significantly ($p > 0.05$). There was no statistically significant difference between patients treated with (n = 15) and without (n = 20) fixation of the anterior component of the transverse acetabular fracture in terms of medial displacement of the femoral head. [21]

Yanping et al described the biomechanical mechanism of fixation of T-type acetabulum fractures. Three fixation systems selected in this study were powerful on increasing the approximate biomechanical stability. The third fixation system (P + QS) is the optimal method for T-

shaped fracture in terms of total pelvic stiffness, stress distribution, and screw function. Furthermore, this fixation system entails a short operation time, minor cuts, and low possibility of infection during the surgery. [22]

Ryan et al., in their study on comparison of stability of Pre-contoured Quadrilateral Surface Acetabular Plate with pelvic reconstruction plates observed Under anatomical loading, the pre-contoured plates with anterior column lag-screw fixation demonstrate increased stability in a synthetic bone transverse acetabular fracture model. A transverse acetabular fracture was created in 18 synthetic hemi-pelvises. Six were fixed by each of the 3 methods described. Specimens underwent cyclic axial compressive loading to 1700N for 42,000 cycles while anterior and posterior column displacements were measured, followed 4800N for 50 cycles. Displacement and stiffness data were analysed with analysis of variance and Tukey HSD. A Cox proportional hazards regression model was used to determine survival rate. P values, 0.05 were considered significant [23]

Dodd et al in their study on functional outcomes of surgically managed fractures of acetabulum concluded that the need for evaluation of functional outcomes over radiological ones is increasingly recognised in orthopaedic literature, as is the need to understand them better and ensure they are developed with appropriate scientific rigour. The functional outcomes of 4089 acetabular fractures in 4061 patients were reported at a minimum of three months' follow-up. Mean follow-up time in 61 papers was 52.9 months (14 to 222). Most studies (50 of 69) used the Merle d'Aubigné-Postel hip score (DAP) or Matta's modification of it. Of the 18 available points, the score was interpreted 18 as excellent, 15-17 as good, 13-14 as fair and less than 13 as poor. [24]

Rollman et al in their study on predictors of secondary hip osteoarthritis after acetabular fractures proposed that despite the continuous improvement of surgical techniques and perioperative care to date still every fifth patient with an acetabular fracture develops secondary osteoarthritis of the hip. According to the multicentre data from the

German Pelvic Trauma Registry, the associated risk factors include higher patient age, femoral head lesion, subluxation, and involvement of the posterior wall. The identified risk factors agree with previous research and should be taken into account when treatment of acetabular fractures is planned. Retrospective analysis of 678 acetabular fracture cases without concomitant pelvic ring fracture treated and followed up between January 2004 and May 2015 at six large trauma centres. Multivariate Cox regression analysis was performed assessing the association of patient/treatment characteristics with THA likelihood at an average follow-up of 2.7 years (range 0.4–9.5 years; SD 1.8 years). Overall, the rate of secondary osteoarthritis was 19.8%. The likelihood for THA increased with 6% per age year (95%CI 1.04–1.09) and with 21% per millimetre subluxation (95%CI 1.09–1.33). This likelihood was 3.54 (95% CI 1.77–7.08) and 3.68 times (95% CI 1.87–7.47) higher if the posterior wall was involved and a contusion and/or impaction of the femoral head was present. Other covariates (sex, ISS, trauma type, AO/OTA and Letournel classification, initial displacement, surgical approach, intra-articular fragments, contusion and/or impaction to the acetabulum, reduction, intervention type, duration of surgery, soft tissue damage, residual fracture step/gap, and prevention of heterotopic ossifications) were not significantly associated ($p > 0.15$). [25]

Piazolla et al. conducted a study on the comparison of patient's quality of life before and after the trauma. Out of 28 patients that were followed up, 20 were male and 8 were female. With a mean age of 43 years. Hip dislocation was present in 8 patients. Surgery was performed between day 2 and day 6 of the trauma. Early complications were observed in 5% of the cases with pulmonary embolism in 2 cases, wound dehiscence in 1 case and sciatic nerve palsy in 1 case. According to Matta's criteria, anatomical reduction was achieved in 21 patients, good reduction in 6 patients and poor reduction in 1 patient. Pre-traumatic Quality of Life in patients with surgically treated acetabular fractures is generally high and for SF-36 comparable to a population norm. This implied that although the treatment protocols of acetabular

fractures have greatly improved over the years, these continue to have disabled consequences that hardly allow to recover a good quality of life two years after the trauma. [26]

Giordano et al. conducted a study to determine the validity of both column fixation of transverse fractures of acetabulum. 35 skeletally mature patients (31 male and fou female, with mean age of 39.9 years with combined transverse-posterior wall acetabular fractures surgically treated by a posterolateral single approach were enrolled in this prospective investigation Nineteen patients had associated orthopaedic injuries. The first part of the acetabula fracture management was similar to all patients and consisted in anatomical reduction and fixation of the transverse posterior component followed by anatomical reduction and fixation of the posterior wall component. The transverse anterior component reduction was controlled by fluoroscopic images (anteroposterior (AP), iliac oblique, and obturator oblique views) and digital palpation through the greater sciatic notch. Fifteen of the 35 patients had an additional lag-screw fixation from the posterior to the anterior columns with an extra-long small-fragment cortical screw. AP and Judet oblique radiographic views were taken at the end of the procedure and roof-arc angles were measured. Clinical results were assigned according to the grading system of Merle d'Aubigné´ and Postel as modified by Matta et al. Radiographic roof-arc angles were checked and compared between the two groups of patients to the same data collected both at the time of the surgical procedure and at three months postoperatively. The clinical results were considered satisfactory in 31 (88.6%) patients (excellent in nine (25.7%) and good in 22 (62.9%) patients). [27]

Shrestha et al conducted a retrospective study on acetabular fractures managed with open reduction and internal fixation. Thirty-three patients (Male: 24 Female: 9) with average age 39 years (range: 21 to 65 years) were operated for acetabular fracture. Twenty-one patients (63%) had injury related with motor vehicle accidents and nine (24%) of them had motorbike accidents. Injury hospital interval ranges from 7 to 36 days. Average injury-surgery interval was 21 days and average

hospital stay was 22 days. Bi-columnar fractures were found in 15. Nine patients had dislocation of hip and 15 had concomitant other injuries. Bi-columnar fixation was performed in 15 patients, posterior column and or wall in nine with Kocher Langenback approach and anterior column and or wall in other nine with ilio-inguinal approach. Radiological reduction was anatomical in 18; excellent/good functional outcome was in 26 and radiological outcomes were excellent in 14. Three patients had developed Heterotopic ossification. Follow up period ranged from 6 to 48 months and 15 patients (45%) had follow up >2 years. [28]

MATERIALS AND METHODS

SOURCE OF DATA

Patients included in the study were admitted in department of orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana from January 2016 to January 2019 who had given valid informed consent to take part in the study.

METHOD OF COLLECTION OF DATA

A. Methodology and type of data collected:

After obtaining clearance and approval from the institutional ethical committee, patients fulfilling the inclusion / exclusion criteria were included in the study after obtaining informed consent.

Detailed history was obtained using study proforma with special attention to mechanism of injury, evaluations including base line clinical features, examination of other associated symptoms was based on history and physical examination.

Collection of data of patients presenting with transverse fracture of acetabulum are as follows.

- History.
- Clinical examination both systemic and local.
- Radiological examination using X ray, CT (computerized tomography) scan and other imaging modalities if necessary.
- Investigations – Routine and others.
- Diagnosis- Clinical and radiological.
- Surgery- open reduction and internal fixation of transverse fracture of acetabulum.
- Routine antibiotics and analgesics/anti-inflammatory drugs.
- DVT prophylaxis
- Post operative evaluation by clinical examination and X ray pelvis (AP view, iliac oblique view, obturator oblique view)

Surgical approaches:

- Kocher Langenback approach
- Ilioinguinal approach
- Modified stoppa’s approach

Assessment of complications.

- **Perioperative** –difficulty in reduction, hypotension, shock, hemorrhage, nerve injury, vascular injury, inability to reduce the hip.
- **Immediate post-operative** –Acute Renal Failure (ARF), pulmonary embolism, fat embolism, cardiovascular compromise (MI, ACS), infection, loss of reduction, DVT
- **Late post-operative** -infection, nonunion, malunion, failed fixation, osteoarthritis of hip joint, avascular necrosis of the femoral head, dislocation of femoral head, metal work failure

Clinical follow-up was done at 4 weeks, 3 months, 6 months intervals to assess the pain, healing of fracture, and functional status of the hip.

Radiological follow up by X ray was done at 4 weeks, 3 months, 6months, to assess the reduction and healing status of the hip.

Inclusion Criteria:

1. Transverse fractures of acetabulum (may or may not be associated with anterior or posterior wall fracture of acetabulum)
2. Age group 18 to 70 years of either sexes.
3. Patients who give informed consent and willing for follow up.

Exclusion Criteria:

1. Patients less than 18 years of age.
2. Patients unfit for surgery.
3. Pregnant patients
4. Open fractures
5. Pathological fractures
6. Patients managed conservatively
7. Patients managed with hip replacement
8. Fracture > 3 weeks old at the time of surgery

Study design: Prospective & Retrospective

Study duration: 3 Years

Place of study: Inpatients in Department of Orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana.

Surgical approaches:

Surgical exposure is of great value in acetabular fracture surgery as accurate reduction and fixation can be possible with good surgical

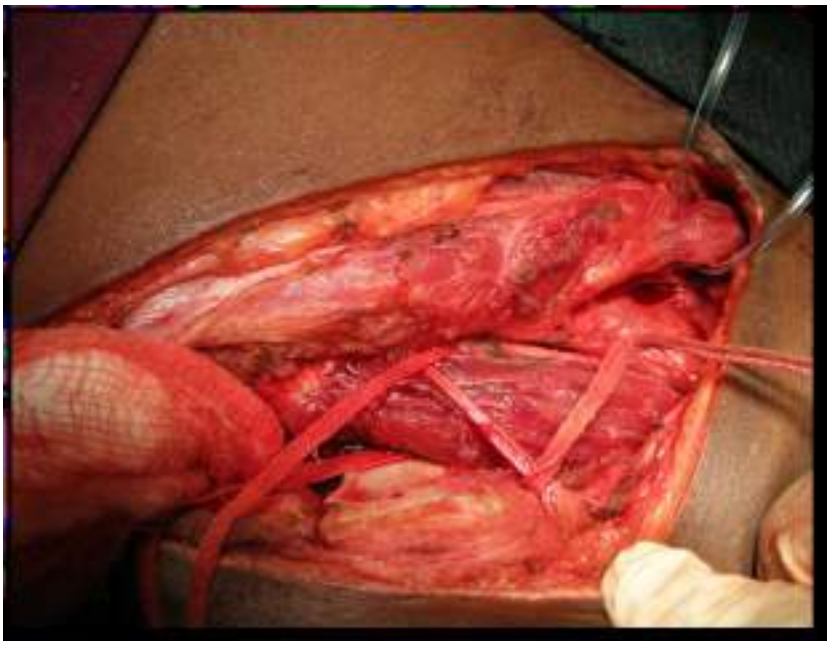
exposure. Extensile approaches like extended iliofemoral and triradiate have much complications like skin necrosis, vascular compromise to abductors and heterotopic ossification. We had used non extensile approaches either alone or in combination. They are

1. Anterior ilioinguinal approach
2. Posterior Kocher-Langenback approach.

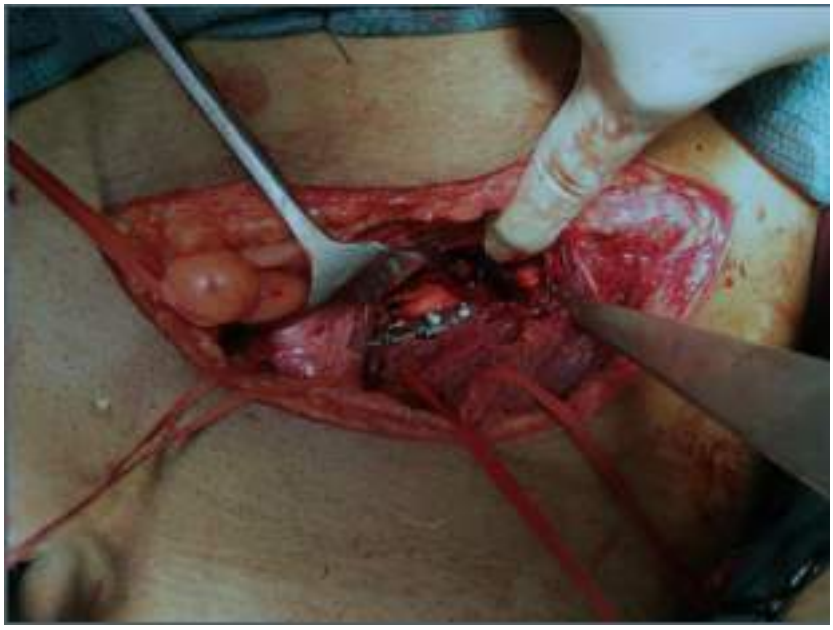
Anterior ilioinguinal Approach

Patient was placed on radiolucent operating table in supine position. Skin incision was placed in midline 2 fingerbreadths above the symphysis pubis, extended to the anterior superior iliac spine and then continued posteriorly along the line of the iliac crest. The aponeurosis of the external oblique was incised in line with the skin incision. An incision was carefully made along the inguinal ligament from its medial attachment to the pubis to the anterior superior iliac spine along its fibers. Three windows were created for visualization. The first window was formed by medial retraction of the iliopsoas and femoral nerves allowing visualization of the entire internal iliac fossa, the sacroiliac joint, and the pelvic brim. After mobilizing the iliopsoas muscle, Iliopectineal fascia was palpated and its medial and lateral surfaces was defined before its division. Blunt dissection was continued below the vessels. The second window was created by lateral retraction of the iliopsoas and femoral nerve, combined with medial retraction of the external iliac vessels and third window by lateral retraction of the vessels.

Picture 6 Incision for anterior ilioinguinal approach



Picture 7 Structures dividing the 3 windows: iliac crest, lateral cutaneous nerve. of thigh, iliopsoas with femoral nerve, femoral vessels and spermatic cord from down upwards.

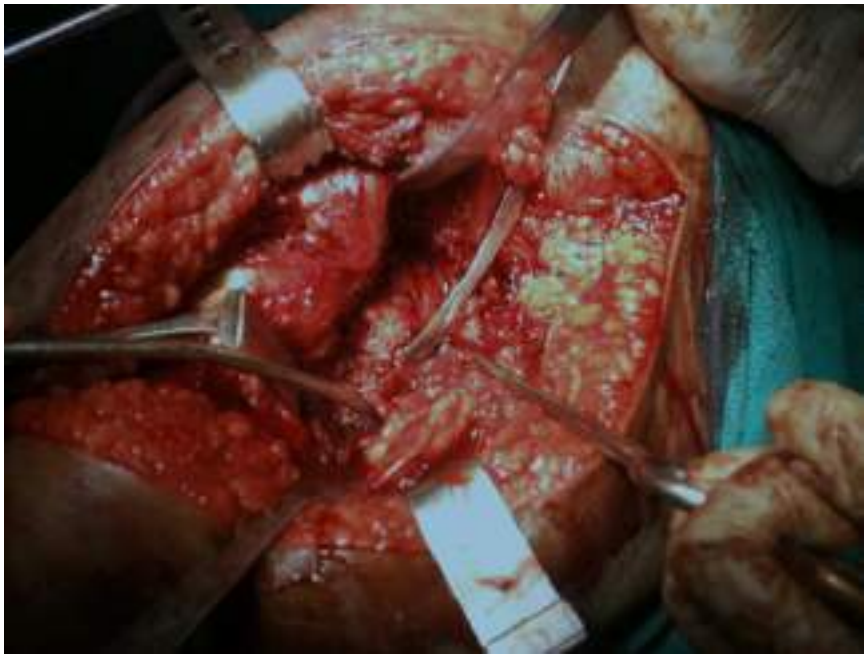


Picture 8 Anterior Ilioinguinal approach with its 3 windows after plating

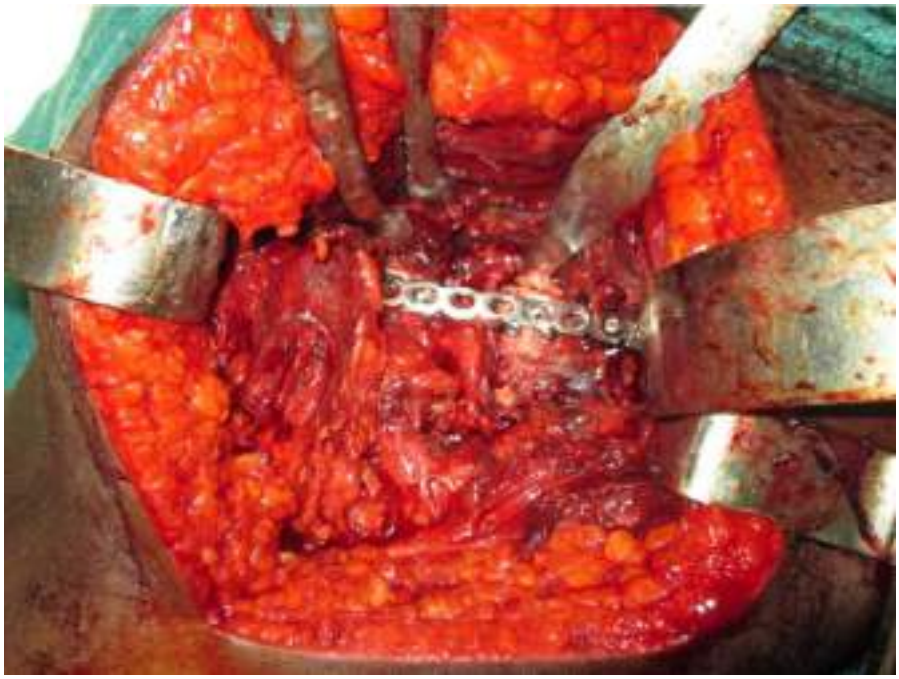
Kocher-Langenback approach:

The patient was usually positioned in a prone position on radiolucent table. Skin incision was placed lateral to the posterior superior iliac spine, extended to the greater trochanter, and then continued along the axis of the femur to almost the midpoint of the thigh. The sciatic nerve was identified on the posterior surface of the quadratus femoris and followed proximally until it disappears beneath the piriformis. The tendons of the piriformis and obturator internus are transected at their trochanteric insertion and retracted posteriorly, exposing the greater and lesser sciatic notch. Subperiosteal elevation was done to exposes the inferior aspect of the iliac wing.

A trochanteric osteotomy can help in further visualization of the inferior iliac wing and the interior of the joint. Alternatively, the tendon of the gluteus Medius can be partially transected. The gluteus maximus tendon was transected at its femoral insertion if needed.



Picture 9 Kocher-langenback approach with exposed short external rotators



Picture 10 Posterior Kocher-Langenback approach after lag screws and buttress plating.

Pre- operative regimen:

A detailed history was taken from the patient presenting to the hospital emergency department. Assessment of airway. Breathing and circulation was done first and managed accordingly. Patient underwent complete physical examination to evaluate the extent of injuries and neurovascular status. Analgesics, blood products and I/V fluids were administered as per requirement. Patient was resuscitated and routine investigations and radiographs were done. Any co-existing comorbidities such as diabetes mellitus, smoking, hypertension etc. were evaluated accordingly. Pre anesthetic consultation was taken and the patient was planned for surgery when fit.

Post- operative regimen:

Post-operative X-rays were done to check the reduction and fixation of fracture. Skeletal/Skin traction was applied if deemed necessary by the operating surgeon. Patient underwent appropriate physiotherapy as tolerated. I/V antibiotics and analgesics were cont9inued as per protocol. Appropriate DVT prophylaxis was given. After discharge from the hospital, the patient was called for regular follow up for dressing and repeat radiographs and for assessing the functional status of hip. Weight bearing was allowed according to the radiological and clinical results. The patients were analyzed for complications such as infection, limb shortening, deformity at the joint, implant failure, nonunion, delayed union, post traumatic arthritis, heterotopic ossification etc.

OUTCOME

Final radiological and functional outcome at six months follow up using Merle d'Aubigné- Postel Scores. Follow up was also done at 4 weeks and 3 months for assessing the functional status and repeat radiographs.

STATISTICAL ANALYSIS

The data collected was recorded in a proforma and was analyzed using appropriate observational statistical methods.

OBSERVATIONS AND RESULTS

The following observations were made from the data collected during the study on “Clinical and radiological outcomes of surgically managed patients of transverse fractures of acetabulum” in the department of orthopaedics, DMCH, Ludhiana. This study is a prospective and retrospective study conducted on a total of 20 cases of transverse fractures of acetabulum in this hospital, which met the inclusion criteria. The patients were followed up for a minimum period of 6 months during treatment and a maximum period of 2 years. The data is being presented here.

Table 1: Distribution of patients according to age

AGE	No. of cases	Percentage
< 20	2	10.0%
21-30	5	15.0%
31-40	5	15.0%
41-50	2	10.0%
51-60	3	25.0%
> 60	3	25.0%
Total	20	100.0%

	N	Minimum	Maximum	Mean	SD
Age	20	15.0	75.0	45.5	18.4

Out of 20 patients included in the study, the age ranged widely from 20 years to 60 years with mean age of 45.5 years and standard deviation of 18.4.

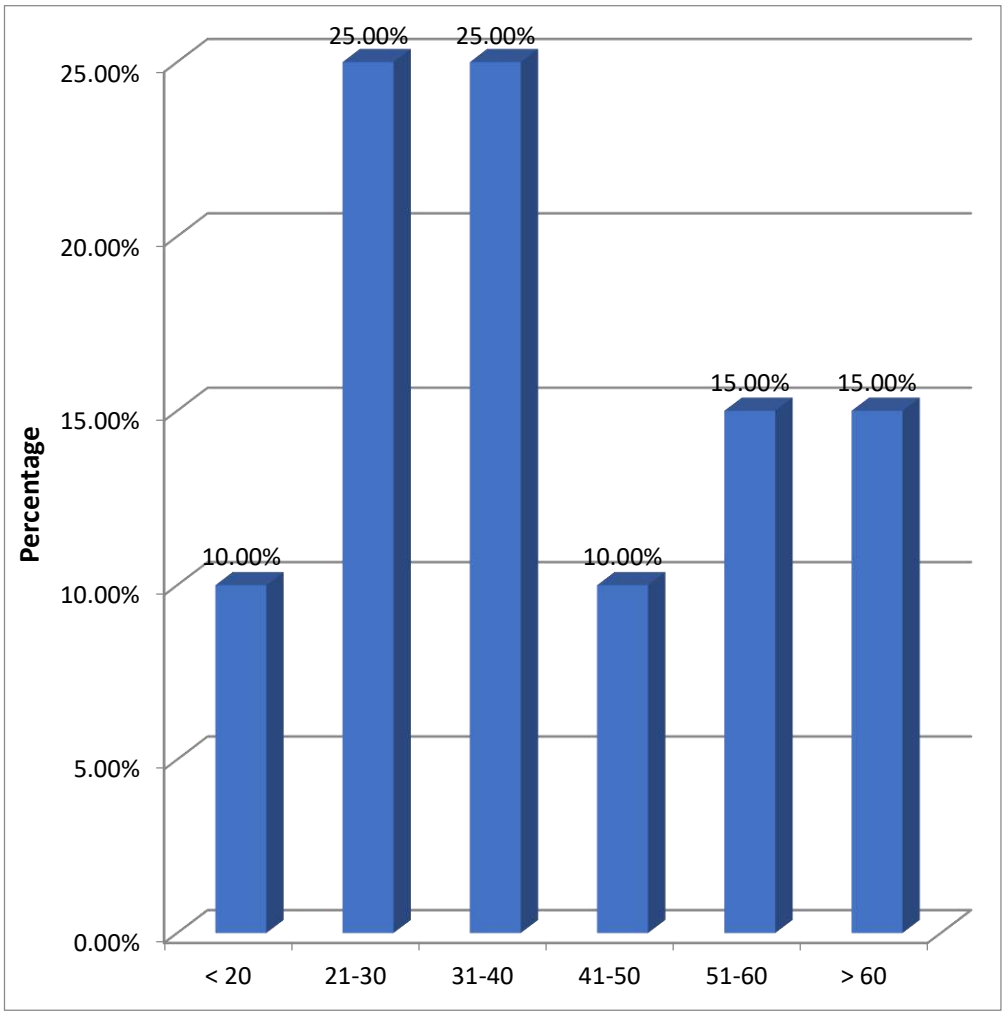


Figure 1: Distribution of patients according to age

Table 2: Distribution of patients according to gender

SEX	No. of cases	Percentage
F	5	25.0%
M	15	75.0%
Total	20	100.0%

Out of the total 20 patients included in our study, 15 patients [75%] were males and 5 patients [25%] were female with a Male to Female ratio of 3:1. Therefore, there has been a higher incidence of transverse fracture of acetabulum among males in our study.

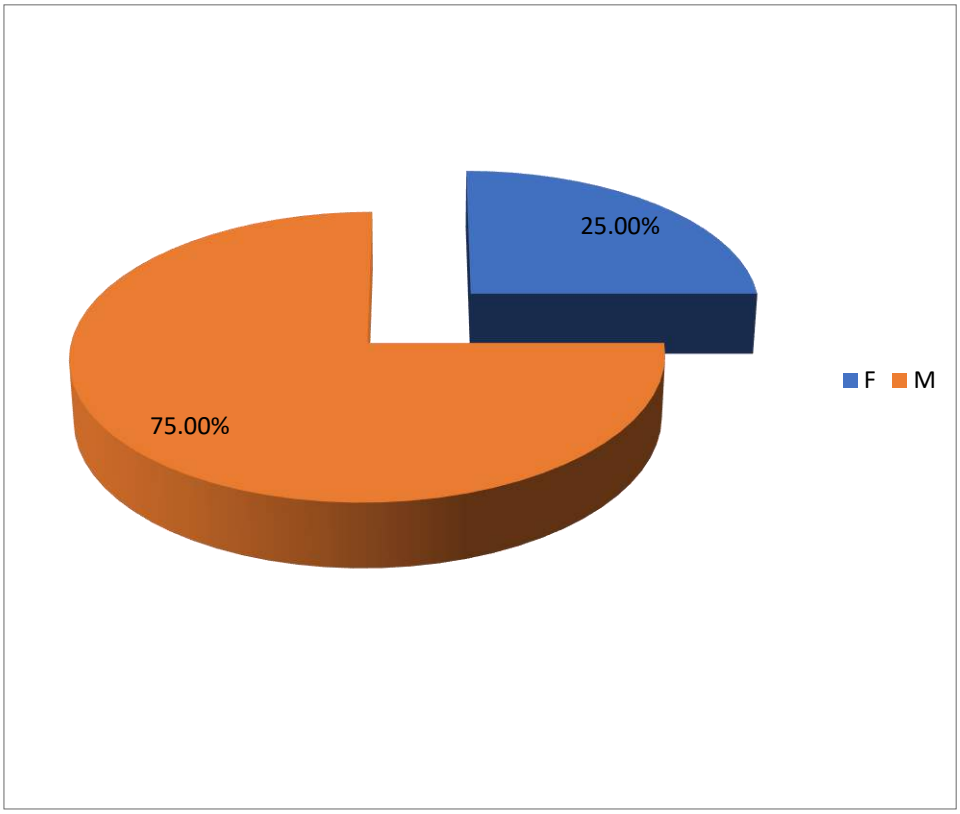


Figure 2: Distribution of patients according to gender

Table 3: Distribution of patients according to the mode of injury.

MODE OF INJURY	No. of cases	Percentage
FALL FROM HEIGHT	3	15.0%
RSA	17	85.0%
Total	20	100.0%

Roadside accidents were the most common cause of transverse fractures of acetabulum in our study. Out of 20 patients included in the study, majority [85%, 17 patients] had roadside accident as a cause of their injuries, followed by fall from height [15%, 3 patients].

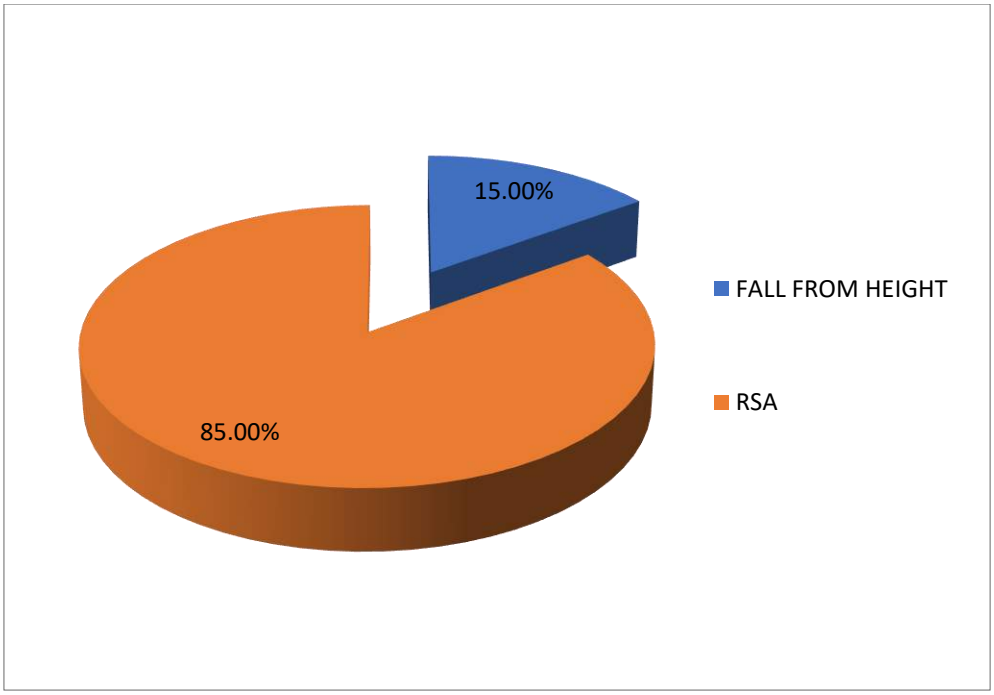


Figure 3: Distribution of patients according to the mode of injury

Table 4A: Distribution of fracture according to the type of fracture [Letournel and Judet classification]

Fracture classification	No. of cases	Percentage
Bi-columnar fractures	6	30.0%
Transverse fracture	12	60.0%
Transverse fracture + posterior wall fracture	2	10.0%
Total	20	100.0%

Table 4B: Distribution of patients according to the type of fracture [open/closed]

OPEN/ CLOSED FRACTURE	No. of cases	Percentage
CLOSED	20	100.0%
Total	20	100.0%

All the fractures of acetabulum were graded according the Letournel and Judet classification. Out of 20 patients participating in the study, majority [60%, 12 patients] had transverse fracture of acetabulum followed by 6 patients [30%] with bi-columnar fracture acetabulum. Remaining 2 patients [10%] had transverse fracture along with fracture of posterior wall. All 20 of the patients participating in the study had closed fracture type.

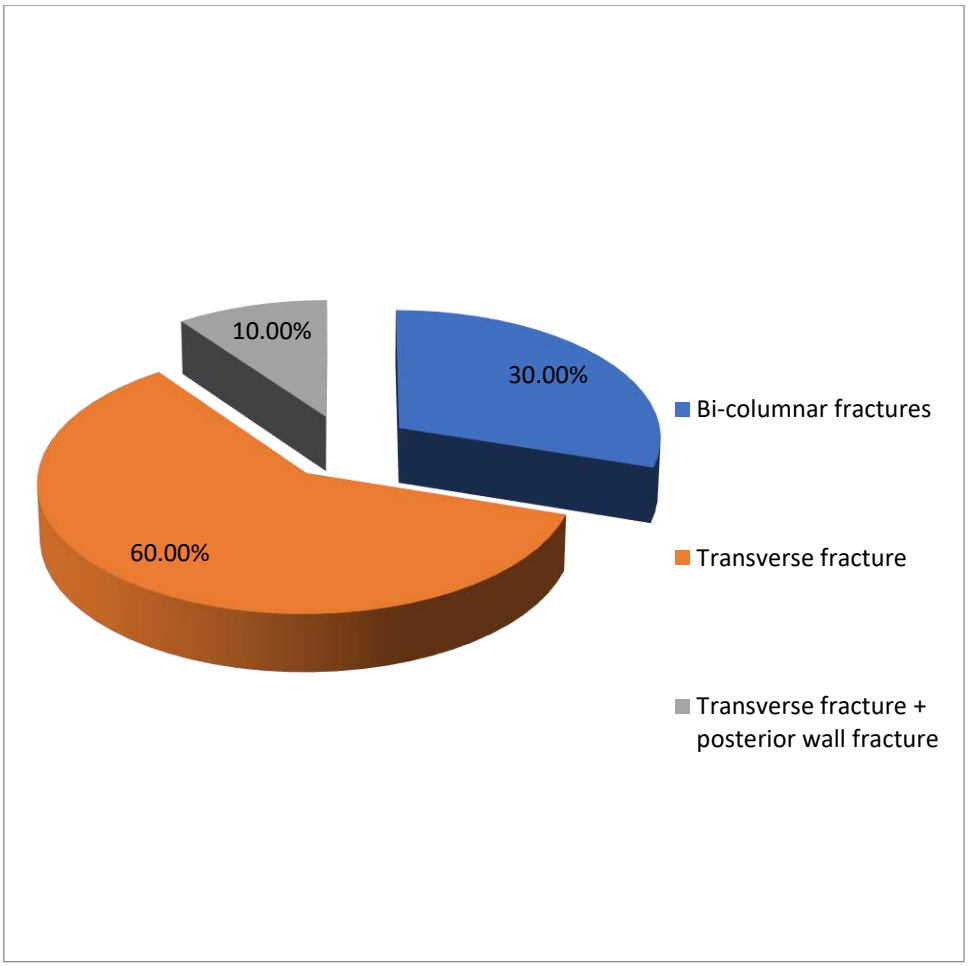


Figure 4: Distribution of fracture according to the type of fracture [Letournel and Judet classification]

Table 5: Distribution of patients according to the type of fracture [AO classification]

Fracture classification (AO Classification)	No. of cases	Percentage
62-B1	12	60.0%
62-B2	7	35.0%
62-B3	1	5.0%
Total	20	100.0%

Of the 20 patients that participated in the study, majority [12 patients, 60%] of the patients had fracture classified as 62-B1, followed by 7 patients [35%] with fracture classified as 62-B2 and only 1 patient with fracture acetabulum classified as 62-B3.

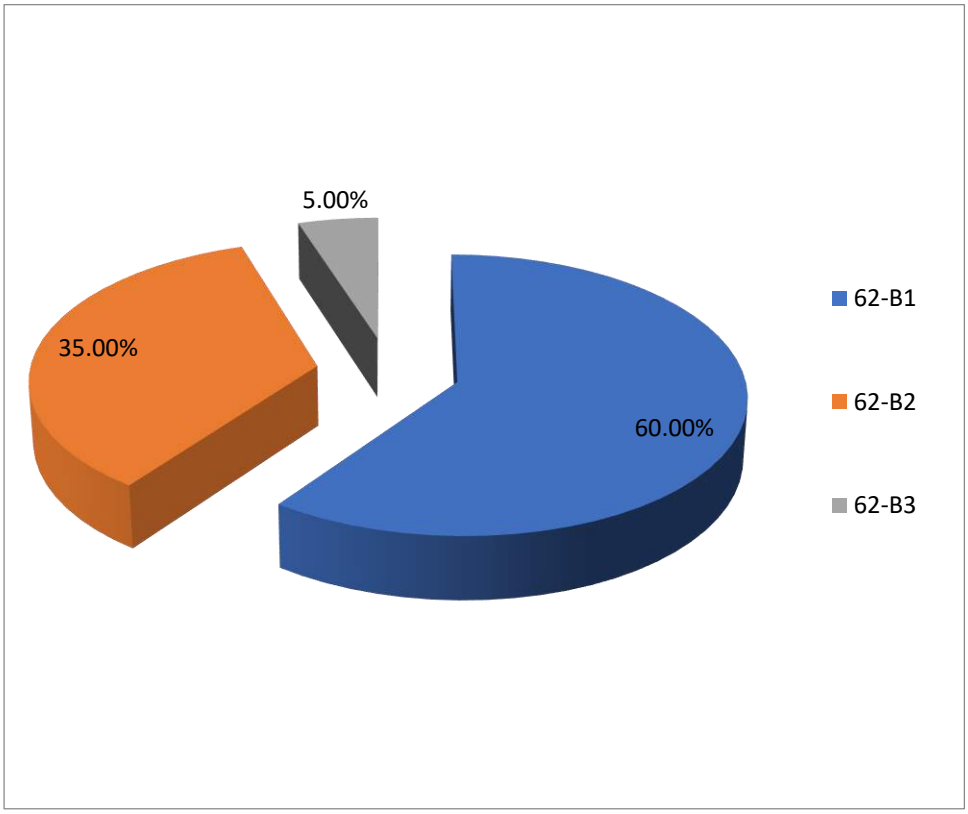


Figure 5: Distribution of patients according to the type of fracture [AO classification]

Table 6: Distribution of patients according to associated injuries

Associated injuries	No. of cases	Percentage
CNS	7	35.0%
CHEST	3	15.0%
ABDOMEN	4	20.0%
MUSCULOSKELETAL INJURIES	10	50.0%
PELVIC RING	5	25.0%
SPINE	2	10.0%
NONE	4	20.0%

Out of the 20 patients included in the study, only 4 patients [20%] had isolated fractures of acetabulum while 80% had one or more associated injuries of various major organ systems. 10 out of 20 patients [50%] had associated long bone fractures and other musculoskeletal injuries. 7 patients [35%] had associated CNS/head injuries. 3 patients out of 20 had associated chest trauma along with fracture acetabulum. Majority [10 patients, 50%] of the patients had associated musculoskeletal injuries including long bone fractures of either upper or lower limbs [5 patients, 25%]. Out of 20 patients that were followed up, 2 patients had associated fracture of contralateral acetabulum. One out of twenty patients had associated fracture of ipsilateral calcaneum. One out of 20 patients had maxilla-facial injuries.

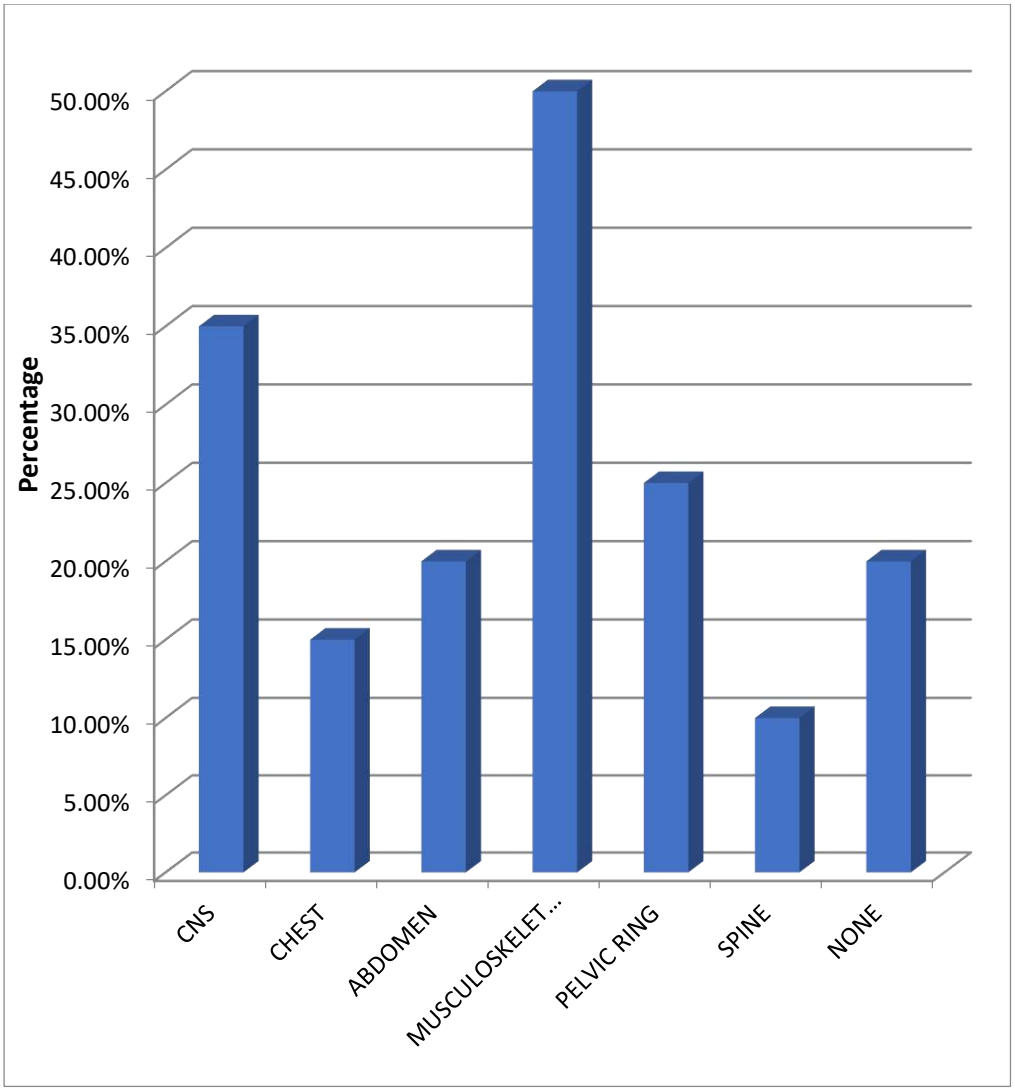


Figure 6: Distribution of patients according to associated injuries

Table 7: Distribution of patients based on hip dislocation

Hip dislocation	No. of cases	Percentage
NONE	13	65.0%
DISLOCATED	7	35.0%
Total	20	100.0%

Out of 20 patients that participated in our study, majority [13 patients, 65%] with transverse fracture acetabulum did not have associated dislocation of hip joint. Hip dislocation was seen in 7 patients [35%] of the patients.

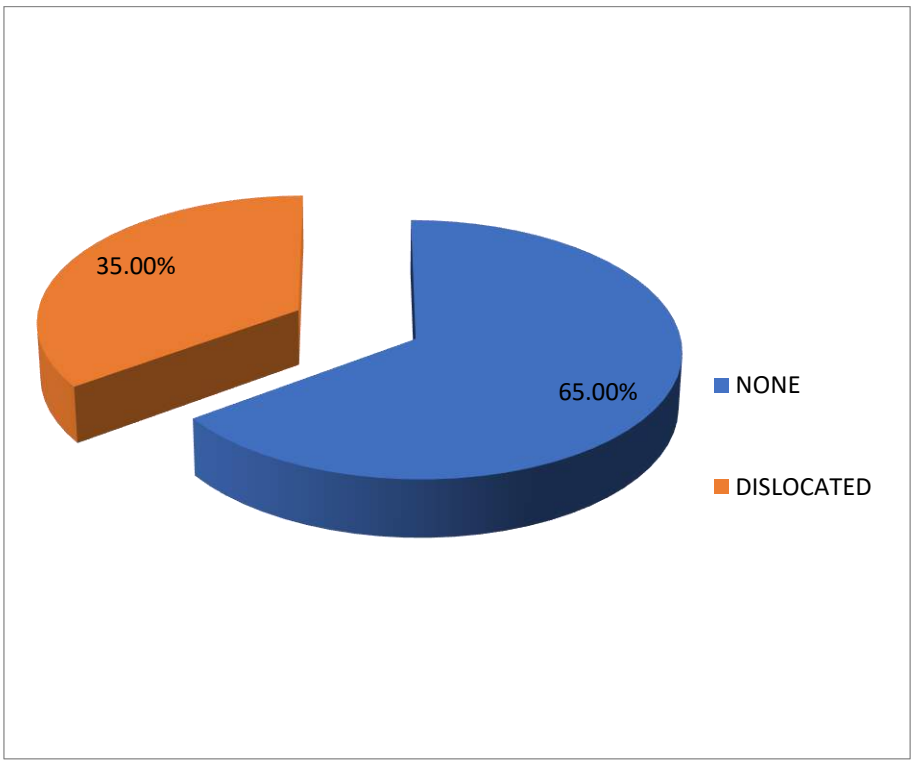


Figure 7: Distribution of patients based on hip dislocation

Table 8: Distribution of patients according to the type of anaesthesia

GA/Spinal Anaesthesia	No. of cases	Percentage
GA	14	70.0%
SPINAL + EPIDURAL	6	30.0%
Total	20	100.0%

Out of total 20 patients that participated in our study, majority [14 patients, 70%] underwent surgery under general anaesthesia and remaining 6 patients [30%] were given combined spinal and epidural anaesthesia.

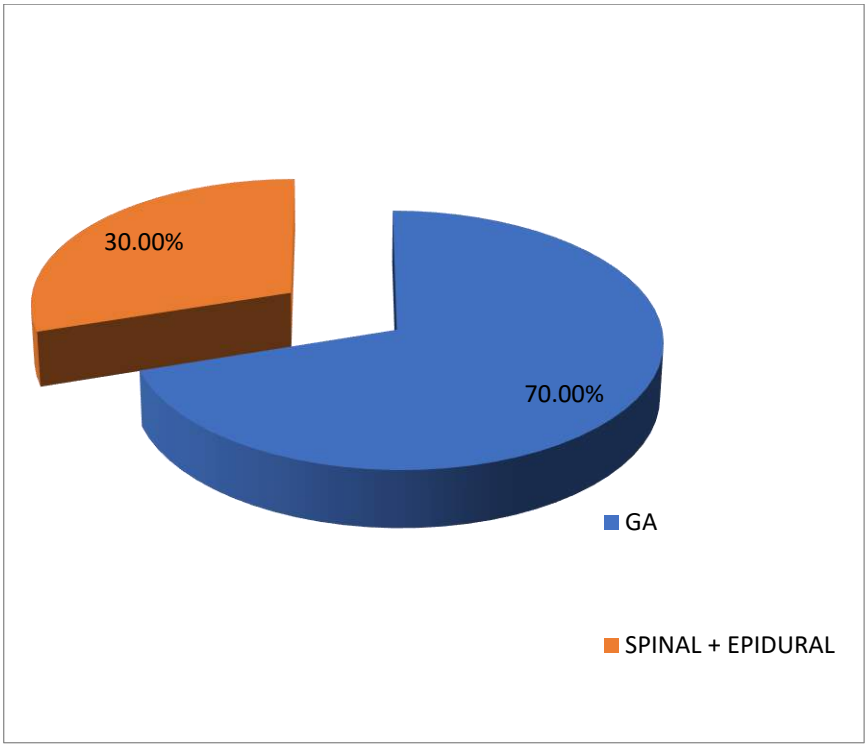


Figure 8: Distribution of patients according to the type of anaesthesia

Table 9: Distribution of patients according to the approach used for fracture fixation

APPROACH	No. of cases	Percentage
ILIOINGUINAL APPROACH	3	15.0%
KL APPROACH	8	40.0%
KL APPROACH + ILIOINGUINAL APPROACH	2	10.0%
MODIFIED STOPPA'S APPROACH	3	15.0%
KOCHER-LANGENBACK + ILIOFEMORAL APPROACH	4	20.0%
Total	20	100.0%

Out of the total 20 cases included in the study, in majority [8 patients, 40%] underwent posterior column fixation via the Kocher-Langenback approach alone. 3 patients [15%] were operated via the ilio-inguinal approach and 3 patients [15%] were operated through the modified stoppa's approach. 4 patients [20%] out of total 20 patients were operated through combined kocher-langenback approach and ilio-femoral approach. The remaining 2 patients [10%] were operated via the combined Kocher-Langenback approach and ilio-inguinal approach.

Table 10: Distribution of patients according to the implant type used

IMPLANT TYPE	No. of cases	Percentage
PELVIC RECONSTRUCTION PLATE	20	100.0%
PELVIC RC PLATE + 4.5 MM PARTIALLY THREADED CC SCREWS	9	45.0%
PELVIC RC PLATE + 3.5MM CORTICAL SCREW	6	30.0%
Total	20	100.0%

Out of the 20 patients included in our study, all 20 cases [100%] cases were fixed with pelvic reconstruction plates either through anterior approach, posterior approach or combined approach. In 12 cases out of total 20 cases [45%], 4.5mm partially threaded cancellous cannulated screws were used as lag screws. In 6 patients [30%], pelvic reconstruction plates were used along with the 3.5mm cortical screws for fracture fixation.

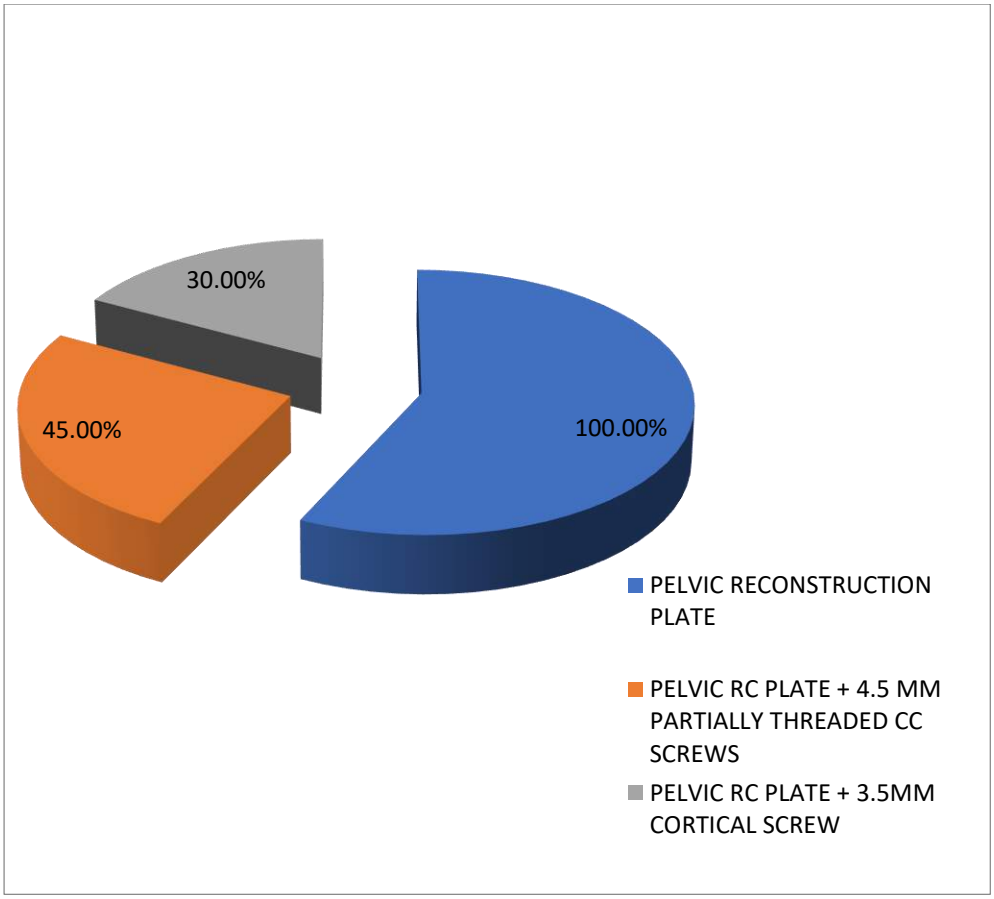


Figure 9: Distribution of patients according to the implant type used

Distribution of patients according to the complications

The complications in the cases included in the study were divided into intra-operative, early post-operative and delayed post-operative complications

Table 11A: Distribution of patients according to intra-operative complications

COMPLICATIONS [Intra-op]	No. of cases	Percentage
YES	1	10.0%
No	19	90.0%
Total	20	100.0%

Of the total 20 cases included in the study, only one case suffered an intra-operative complication in the form of vascular injury to the internal iliac artery. The patient was immediately shifted to intervention radiology OR and coiling of the affected vessel was done under fluoroscopic guidance.

Table 11B: Distribution of patients according to early and delayed post-operative complications

COMPLICATIONS [post-op]	No. of cases	Percentage
AVN FEMORAL HEAD	2	10.0%
MYOSITIS OSSIFICANS (PROXIMAL FEMUR)	1	5.0%
POST TRAUMATIC ARTHRITIS	8	45.0%
SCIATIC NERVE PALSY	1	5.0%
DISCHARGE FROM SUTURE LINE		
NONE	7	45%
Total	20	100.0%

Of the total 20 cases included in the current study, majority [8 patients, 45%] suffered from post-traumatic arthritis. Avascular necrosis of the femoral head was seen in 2 patients out of 20 [10%]. One patient out of 20 [5%] suffered from myositis ossificans of proximal thigh. One patient had surgical site infection and discharge from the suture line which required post-operative-exploration and wound wash.

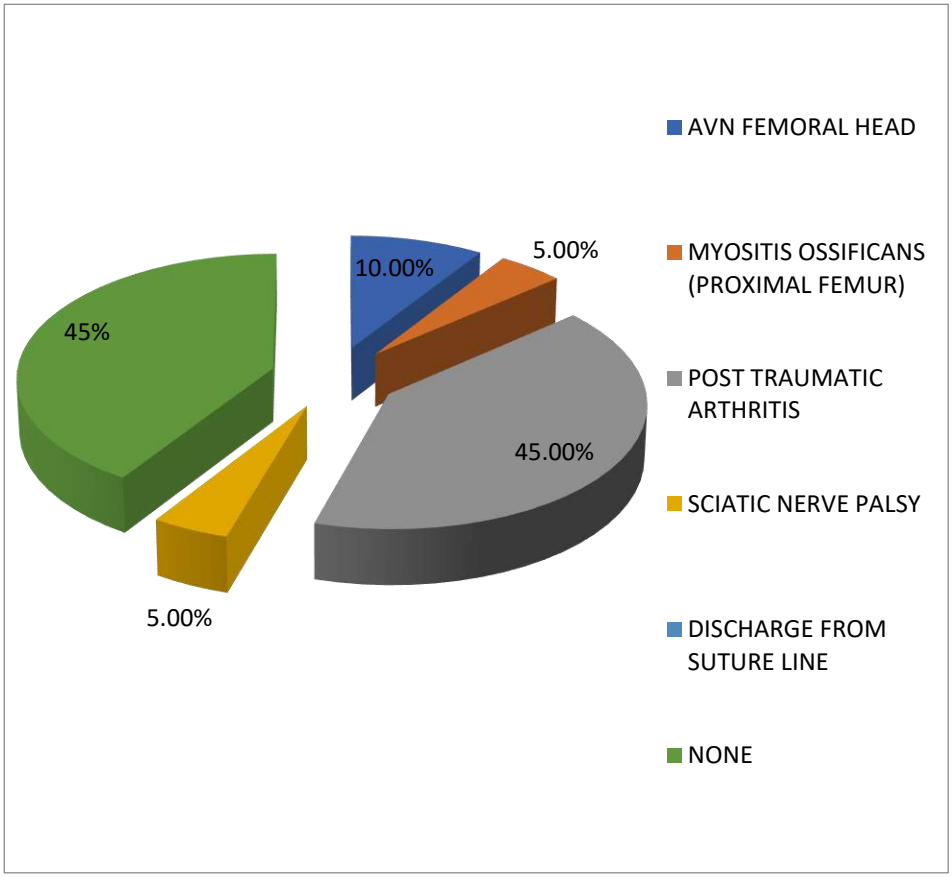


Figure 10: Distribution of patients according to early and delayed post-operative complications

Table 12: Distribution of patients according to need for revision surgery

Revision surgery	No. of cases	Percentage
WOUND EXPLORATION AND WASH	1	5.0%
IMPLANT REMOVAL AND THR	1	5.0%
NONE	18	90.0%
TOTA	20	100.0%

Out of the total 20 patients participating in the study, majority [18 patients, 90%] did not undergo any type of revision surgery/bone grafting procedure. One patient required wound exploration and wound wash. One patient required implant removal and revision THR of the hip joint.

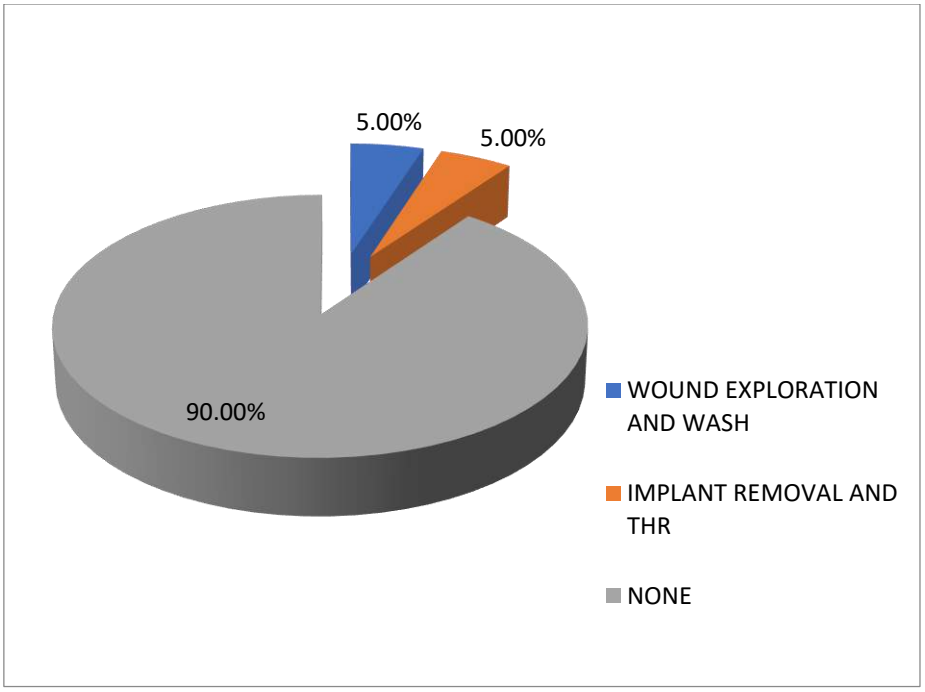


Figure 11: Distribution of patients according to need for revision surgery

Table 13: Distribution of patients according to the radiological result

Radiological result	No. of cases	Percentage
Excellent	9	45.0%
Good	9	45.0%
Fair	1	5.0%
Poor	1	5.0%
Total	20	100.0%

Out of a total 20 patients included in the study, 9 patients (45%) had an excellent radiological result at final follow up, 9 patients (45%) had good radiological result, 1 patient (5%) had fair radiological result and 1 patient (5%) had a poor radiological result. The final follow up radiographs were graded according to the criteria developed by Matta. Radiographic criteria are as follows:

- Excellent – normal appearance of the hip.
- Good – mild changes, small osteophytes, moderate to narrowing of joint space and minimal sclerosis.
- Fair – intermediate changes, moderate osteophytes, moderate narrowing of the joint space, moderate sclerosis.
- Poor – advanced changes, large osteophytes, severe narrowing of joint space, collapse of the femoral head and wear of articular surface of acetabulum.

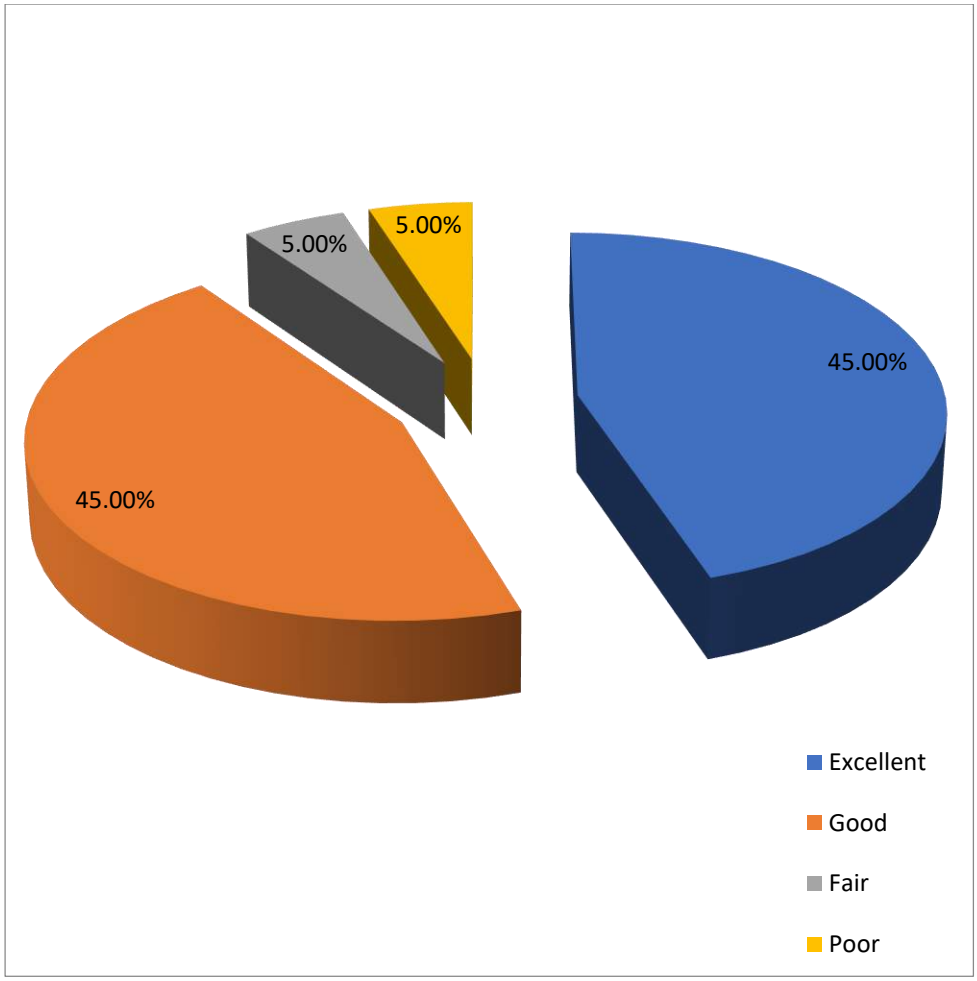


Figure 12: Distribution of patients according to the radiological result

Table 14: Distribution of patients according to return to occupation

	4 WEEKS		3 MONTHS		6 MONTHS	
RETURN TO OCCUPATION	No. of cases	Percentage	No. of cases	Percentage	No. of cases	Percentage
NO	20	100.0%	13	65.0%	2	10.0%
YES	0	0.0%	7	35.0%	18	90.0%
Total	20	100.0%	20	100.0%	20	100.0%

Out of 20 patients included in the study, 18 patients were actively working before the injury and 2 were not working. None of the followed-up patients were able to return to their previous occupation by 4 weeks post operatively. 7 cases out of 20 were able to return to their previous occupations by 3-month period. 18 out of total 20 patients were able to return to their pre-injury occupation by 6 months.

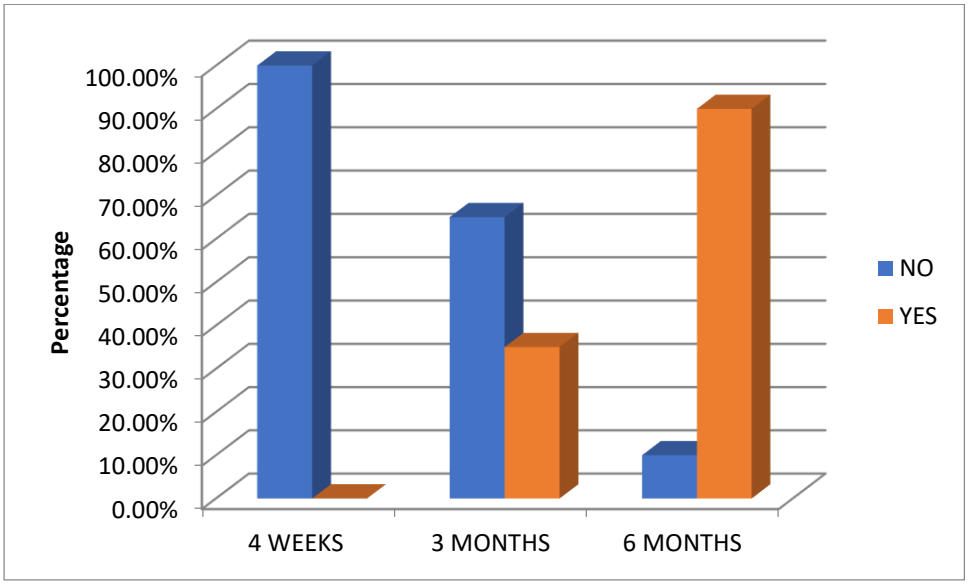


Figure 13: Distribution of patients according to return to occupation

Table 15: Distribution of patients according to weight bearing

	4 WEEKS		3 MONTHS		6 MONTHS	
WEIGHT BEARING	No. of cases	Percentage	No. of cases	Percentage	No. of cases	Percentage
NO	20	100.0%	10	50.0%	1	5.0%
PARTIAL	0	0.0%	0	0.0%	1	5.0%
YES	0	0.0%	10	50.0%	18	90.0%
Total	20	100.0%	20	100.0%	20	100.0%

Of the total 20 patients included in our study, none of the patients were able to bear weight over affected side by the end of 4 weeks. 10 patients were able to bear weight over the affected side after a 3-month post-operative period. After 6 months follow up after surgery, 18 patients out of total 20 [90%] were able to return to their previous occupation.

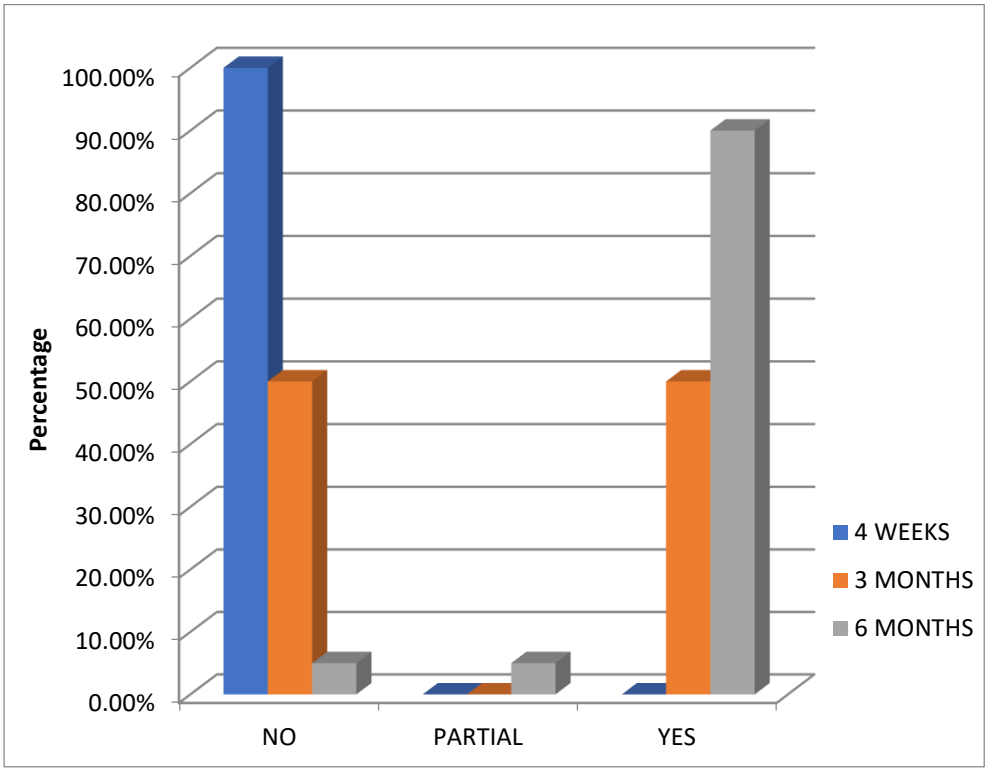


Figure 14: Distribution of patients according to weight bearing

Table 16A: Mean flexion at hip

FLEXION	N	Minimum	Maximum	Mean	SD
4 WEEKS	20	20.0	70.0	42.5	17.0
3 MONTHS	20	20.0	110.0	59.0	22.9
6 MONTHS	20	30.0	120.0	78.0	26.7

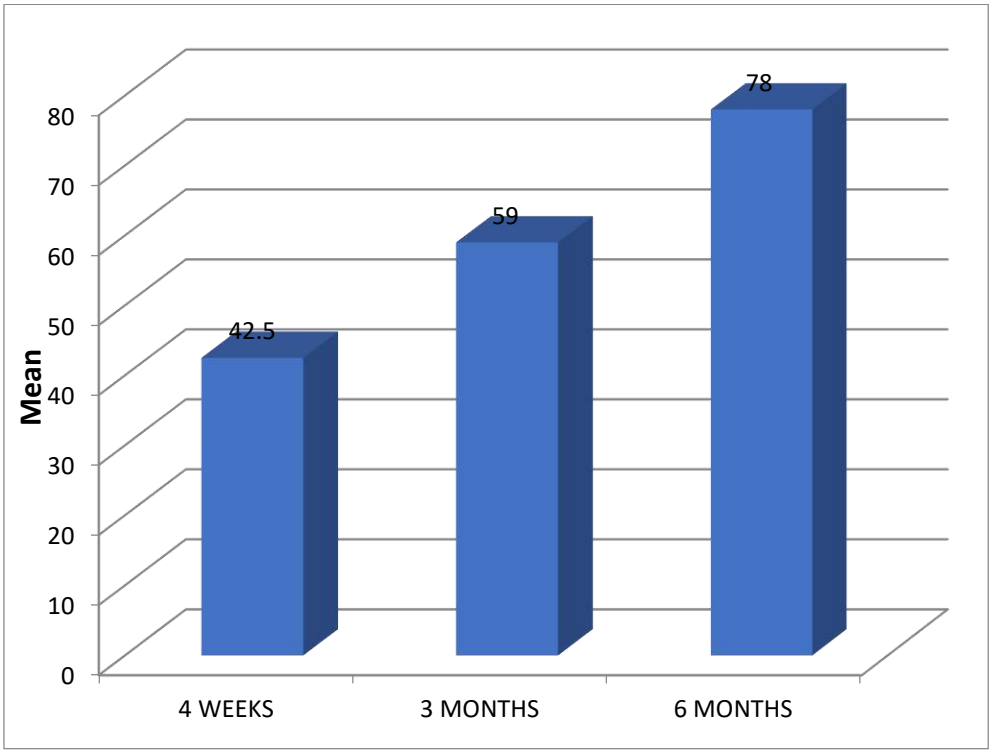


Figure 15A: Mean flexion at hip

Table 16B: Mean extension at hip

EXTENSION	N	Minimum	Maximum	Mean	Std. Deviation
4 WEEKS	20	0.0	5.0	2.3	2.6
3 MONTHS	20	0.0	10.0	5.8	3.4
6 MONTHS	20	0.0	20.0	7.3	4.4

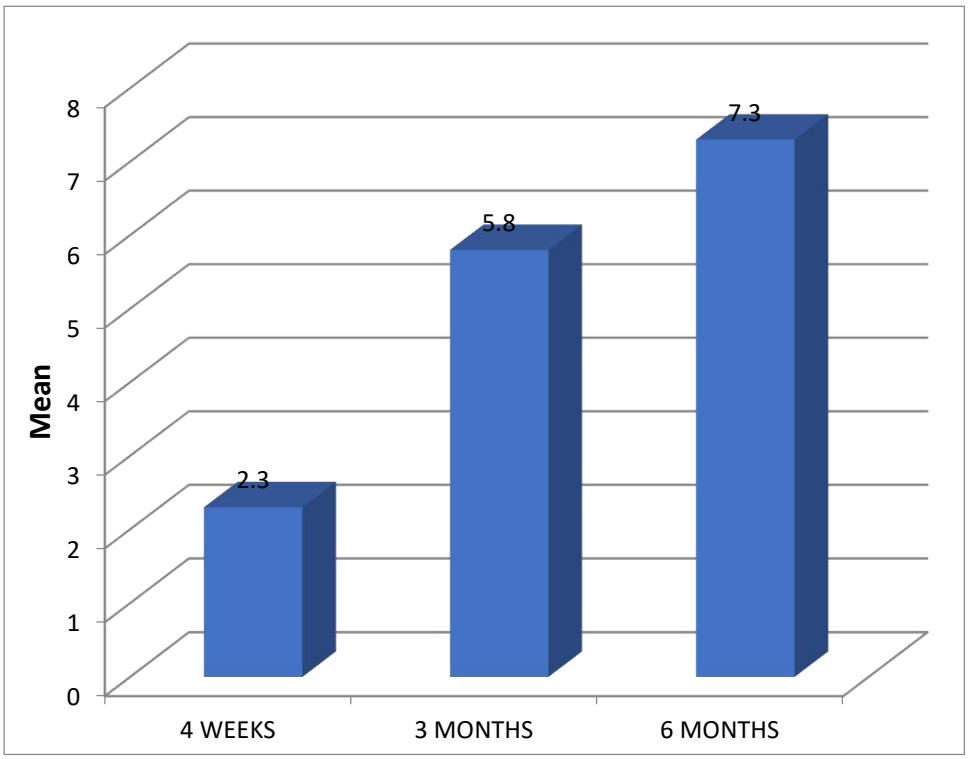


Figure 15B: Mean extension at hip

Table 16C: Mean internal rotation at hip

INTERNAL ROTATION	N	Minimum	Maximum	Mean	SD
4 WEEKS	20	0.0	40.0	20.3	10.6
3 MONTHS	20	0.0	40.0	26.5	10.5
6 MONTHS	20	0.0	45.0	30.3	11.9

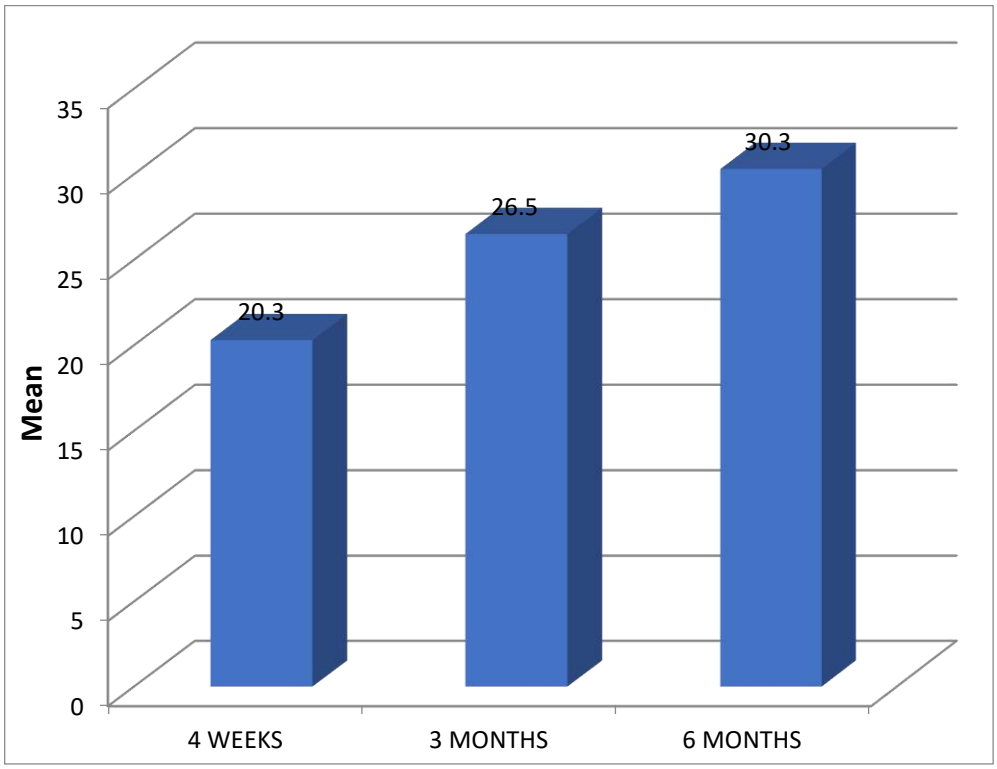


Figure 15C: Mean internal rotation at hip

Table 16D: Mean external rotation at hip

EXTERNAL ROTATION	N	Minimum	Maximum	Mean	SD
4 WEEKS	20	0.0	30.0	17.0	8.3
3 MONTHS	20	0.0	40.0	23.5	10.9
6 MONTHS	20	5.0	40.0	25.8	11.4

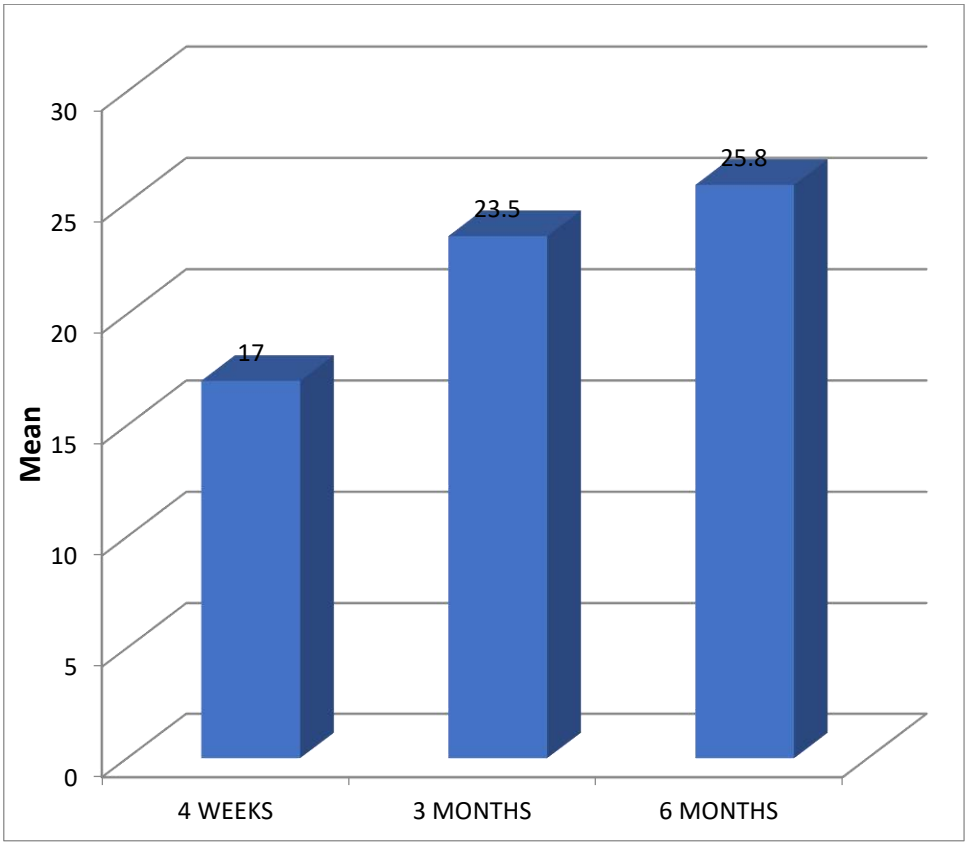


Figure 15D: Mean external rotation at hip

Table 16E: Mean abduction at hip

ABDUCTION	N	Minimum	Maximum	Mean	SD
4 WEEKS	20	0.0	30.0	17.5	9.2
3 MONTHS	20	5.0	40.0	25.8	9.9
6 MONTHS	20	5.0	45.0	27.5	11.1

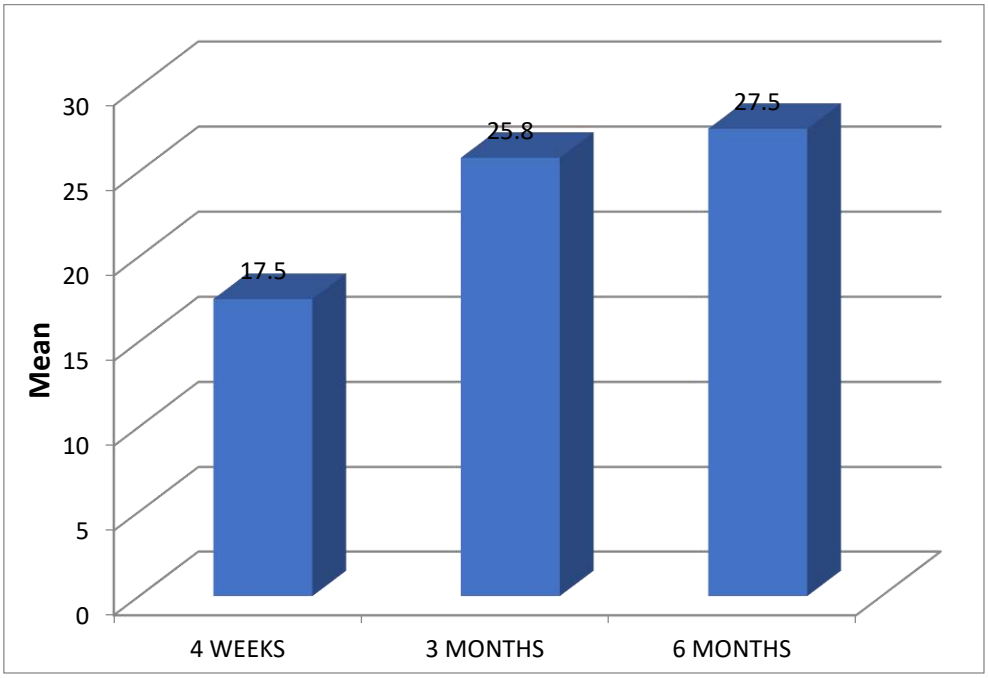


Figure 15E: Mean abduction at hip

Table 16F: Mean adduction at hip

ADDUCTION	N	Minimum	Maximum	Mean	SD
4 WEEKS	20	0.0	20.0	10.8	5.7
3 MONTHS	20	0.0	30.0	15.0	7.4
6 MONTHS	20	0.0	30.0	18.8	8.3

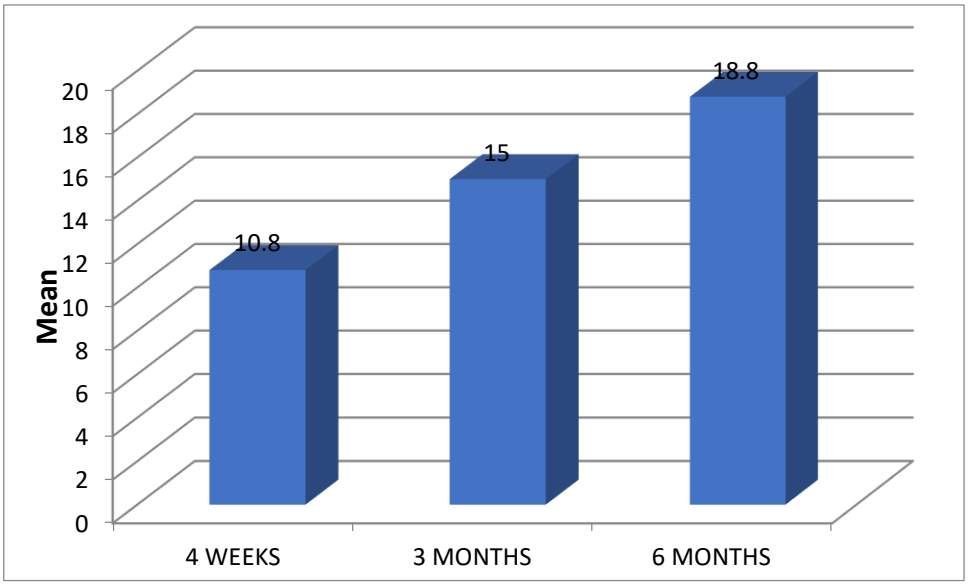


Figure 15F: Mean adduction at hip

16-G Mean range of motion at hip by 6 months post-operative period was:

FLEXION	78°
EXTENSION	7.3°
INTERNAL ROTATION	30.3°
EXTERNAL ROTATION	25.8°
ADDUCTION	18.8°
ABDUCTION	27.5°

Progressive rise in the mean range of motion at hip joint was observed during the follow-up period.

Table 17A: Distribution of patients according the the Merle d'Aubigné and Postel score at 6 months follow-up

Clinical outcome	No. of cases	Percentage
Excellent [>12]	15	75%
Good [7-11]	3	15%
Fair [3-6]	2	10%
Poor [<3]	0	0%
Total	20	100%

According to the Merle d'Aibigne and Postel functional outcome score, out of total 20 patients available for the final follow up, 15 patients [75%] had an excellent score, 3 patients [15%] had good score, 2 patients [10%] had a poor score.

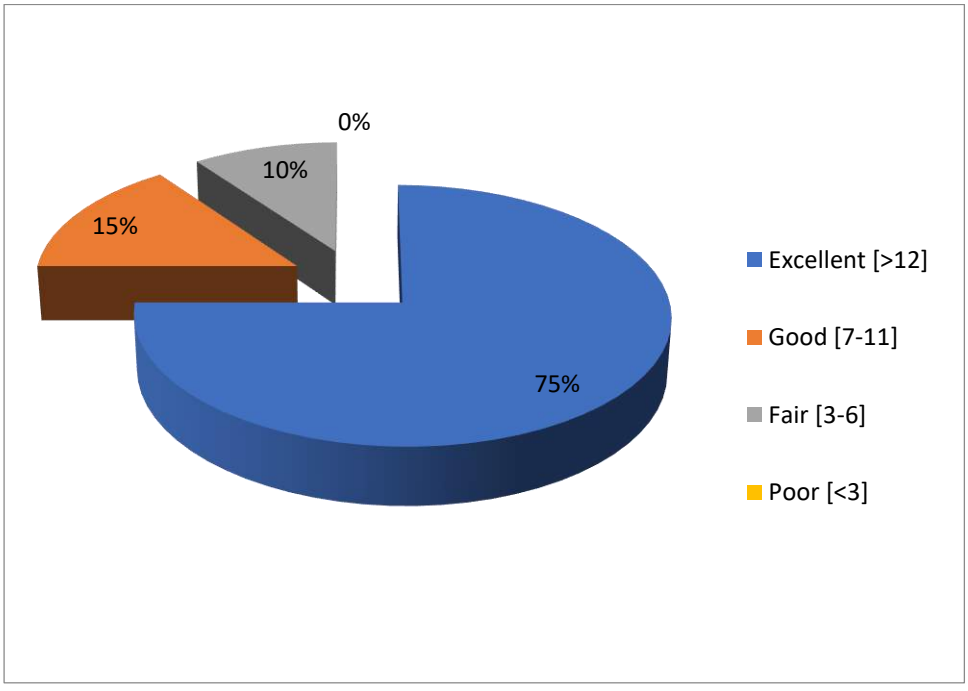


Figure 16A: Distribution of patients according the the Merle d'Aubigné and Postel score at 6 months follow-up

Table 17B: Mean Merle d'Aubigné and Postel score at 6 months follow up

	No	Minimum	Maximum	Mean	Std. Deviation
Pain	20	2.0	6.0	4.7	1.3
Mobility	20	2.0	6.0	4.7	1.2
Ability to walk	20	1.0	6.0	4.7	1.3
Total	20	3	18	14.10	2.8

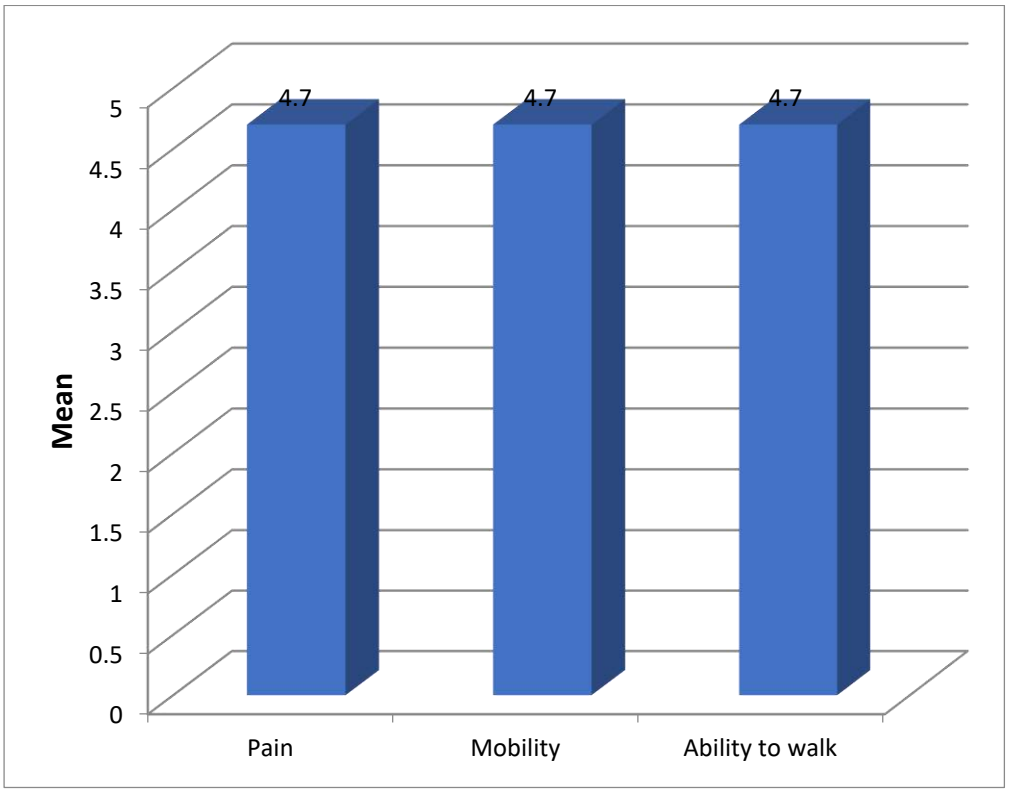


Figure 16B: Mean Merle d'Aubigné and Postel score at 6 months follow up

Table 18A: Distribution of patients according to pain criteria at final 6 month follow up

Score	Pain	No. of cases	Percentage
0	Pain is intense and permanent	0	0.0%
1	Pain is severe, disturbing sleep	0	0.0%
2	Pain is severe while walking, prevents any activity	2	10.0%
3	Pain is severe but tolerated with limited activity	3	15.0%
4	Pain only with exertion and relieved with rest	2	10.0%
5	Little/intermittent pain not precluding normal activity	7	35.0%
6	No pain at all	6	30.0%
Total		20	100%

According to the pain criteria of Merle d' Aubgine and Postel score of functional outcome, out of a total 20 patients available for the final follow up in the study, 6 patients [30%] had a score of 6 with no pain at all, 7 patients [35%] had a score of 5 with little/intermittent pain not precluding normal activity, 2 patients [10%] had a score of 4 experiencing pain only in activity and relieved with rest, 3 patients [15%] had a score of 3 with severe pain tolerated with moderate activity and 2 patients [10%] had a score of 2 with severe pain preventing any activity. None of the patients had the score of 0 with intense and permanent pain.

Table 18B: Mean pain criteria score at 6 months follow up

PAIN	N	Minimum	Maximum	Mean	SD
6 MONTHS	20	2.0	6.0	4.7	1.3

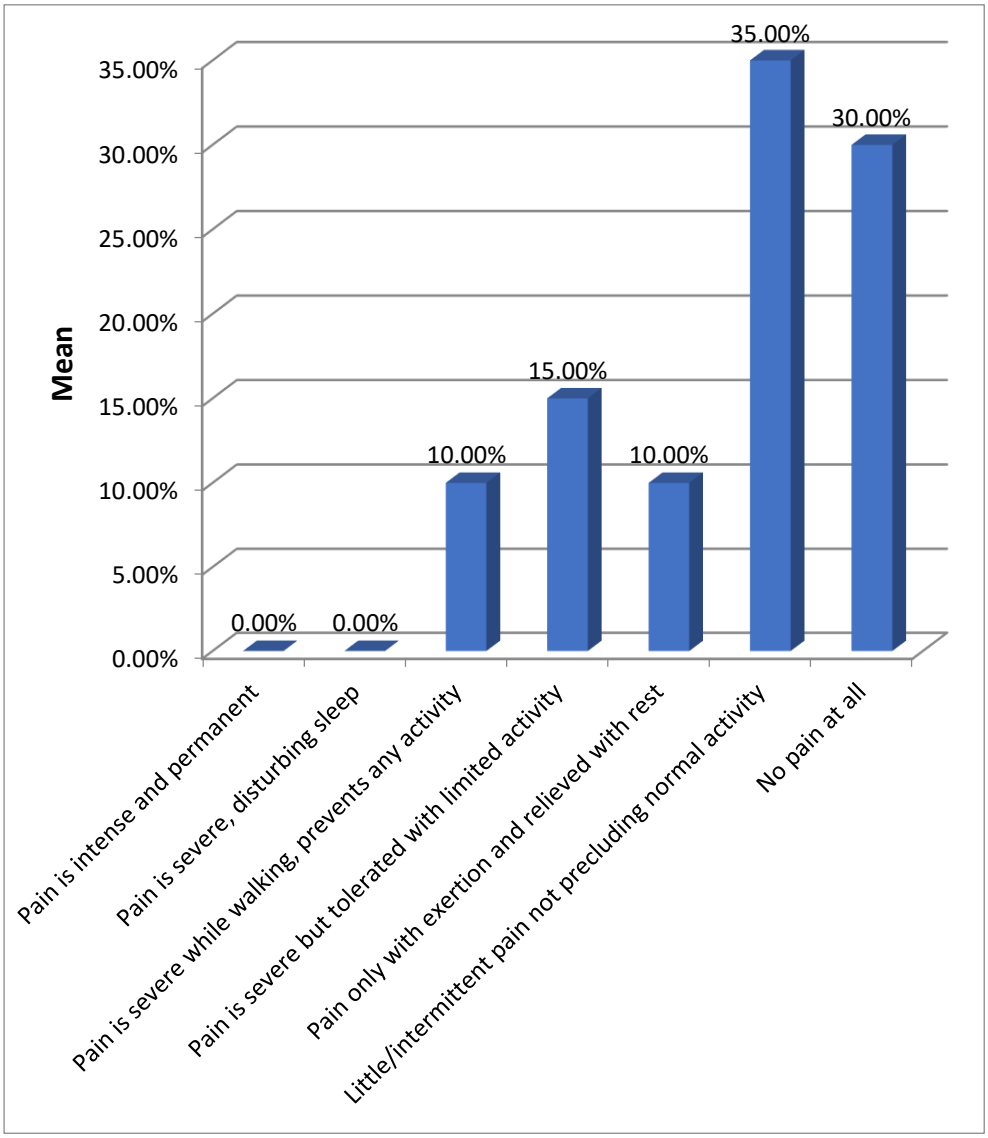


Figure 17: Distribution of patients according to pain criteria at final 6 month follow up

Table 19A: Distribution of the patients according to mobility criteria of Merle d'Aubigné and Postel score at final follow up

Score	Mobility at hip joint	No. of Cases	Percentage
0	Ankylosis with bad position of hip	0	0.0%
1	No movement / slight deformity	0	0.0%
2	Flexion < 40°	1	5.0%
3	Flexion 40°-60°	3	15.0%
4	Flexion 60°-80° [patient can reach his foot]	2	10.0%
5	Flexion 80°-90°, abduction ≥ 15°	9	45.0%
6	Flexion > 90°, Abduction up to 30°	5	25.0%

According to the pain criteria of Merle d' Aubgine and Postel score of functional outcome, out of a total 20 patients available for the final follow up in the study, 5 patients [25%] had a score of 6 with flexion more than 90° and abduction upto 30°, 9 patients [45%] had a score of 5 with flexion of 80°-90° and abduction ≥ 15°, 2 patients [10%] had a score of 4 with flexion of 60°-80°, 3 patients [15%] had a score of 3 with flexion of 40°-60° and 1 patient [5%] had a score of 2 with flexion < 40°. None of the patients had the score of 0 and 1 at the final follow up.

Table 19B: Mean mobility criteria at 6 months follow up

MOBILITY	N	Minimum	Maximum	Mean	SD
6 MONTHS	20	2.0	6.0	4.7	1.2

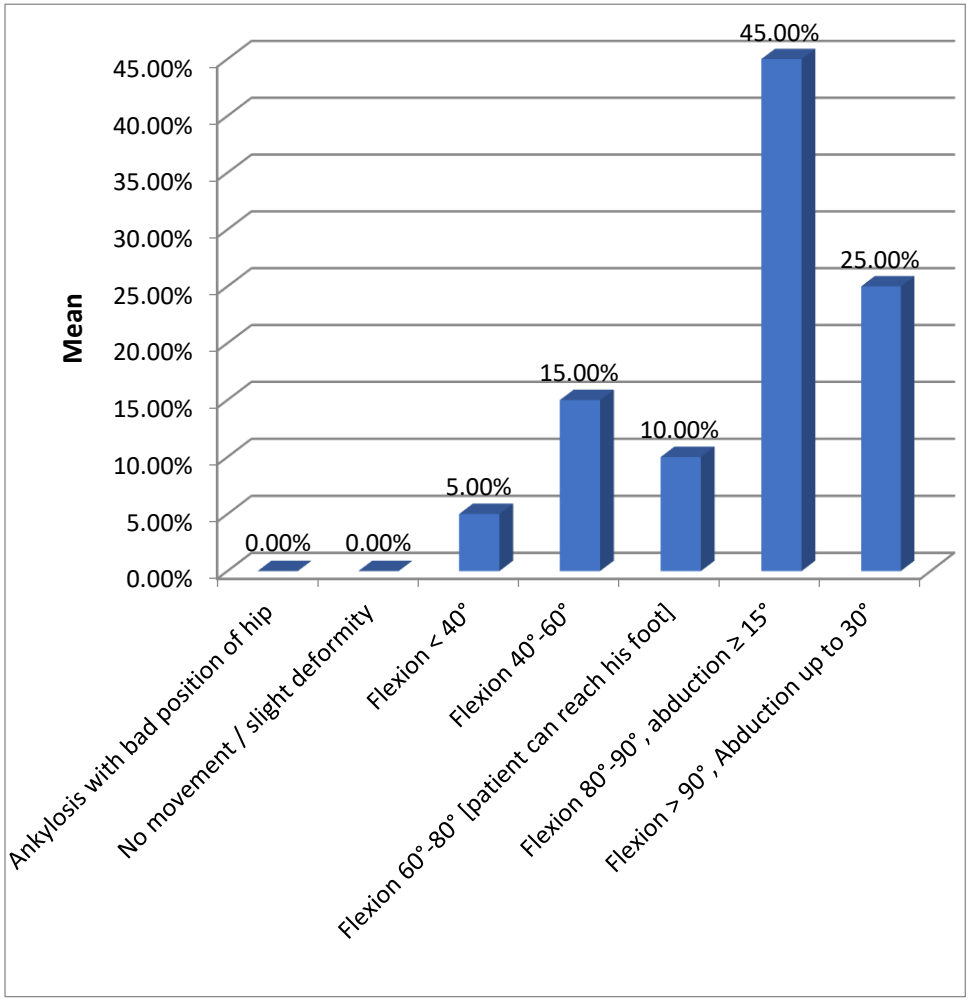


Figure 18: Distribution of the patients according to mobility criteria of Merle d'Aubigné and Postel score at final follow up

Table 20A: Distribution of the patients according to ability to walk criteria of Merle d'Aubigné and Postel score at final follow up

Score	Ability to walk	No. of cases	Percentage
0	Impossible	0	0.0%
1	Only with crutches	1	5.0%
2	Only with 2 canes	1	5.0%
3	Limited with 1 cane [<1hr], very difficult without cane	2	10.0%
4	Prolonged with 1 cane, limited without cane	0	0.0%
5	Without cane with slight limp	12	60.0%
6	Normal	4	20.0%

According to the ability to walk criteria of Merle d' Aubgine and Postel score of functional outcome, out of a total 20 patients available for the final follow up in the study, 4 patients [20%] had the score of 6 with normal ability to walk without any pain or limp, 12 patients [60%] had a score of 5 with ability to walk without a cane with a slight limp, 2 patients [10%] had a score of 3 with limited walking with a cane for < 1 hour, 1 patient [5%] had a score of 2 with ability to walk only with 2 canes and 1 patient [5%] had a score of 1 with ability to walk only with crutches.

Table 20B: Mean ability to walk criteria at 6 months follow up

ABILITY to Walk	N	Minimum	Maximum	Mean	SD
6 MONTHS	20	1.0	6.0	4.7	1.3

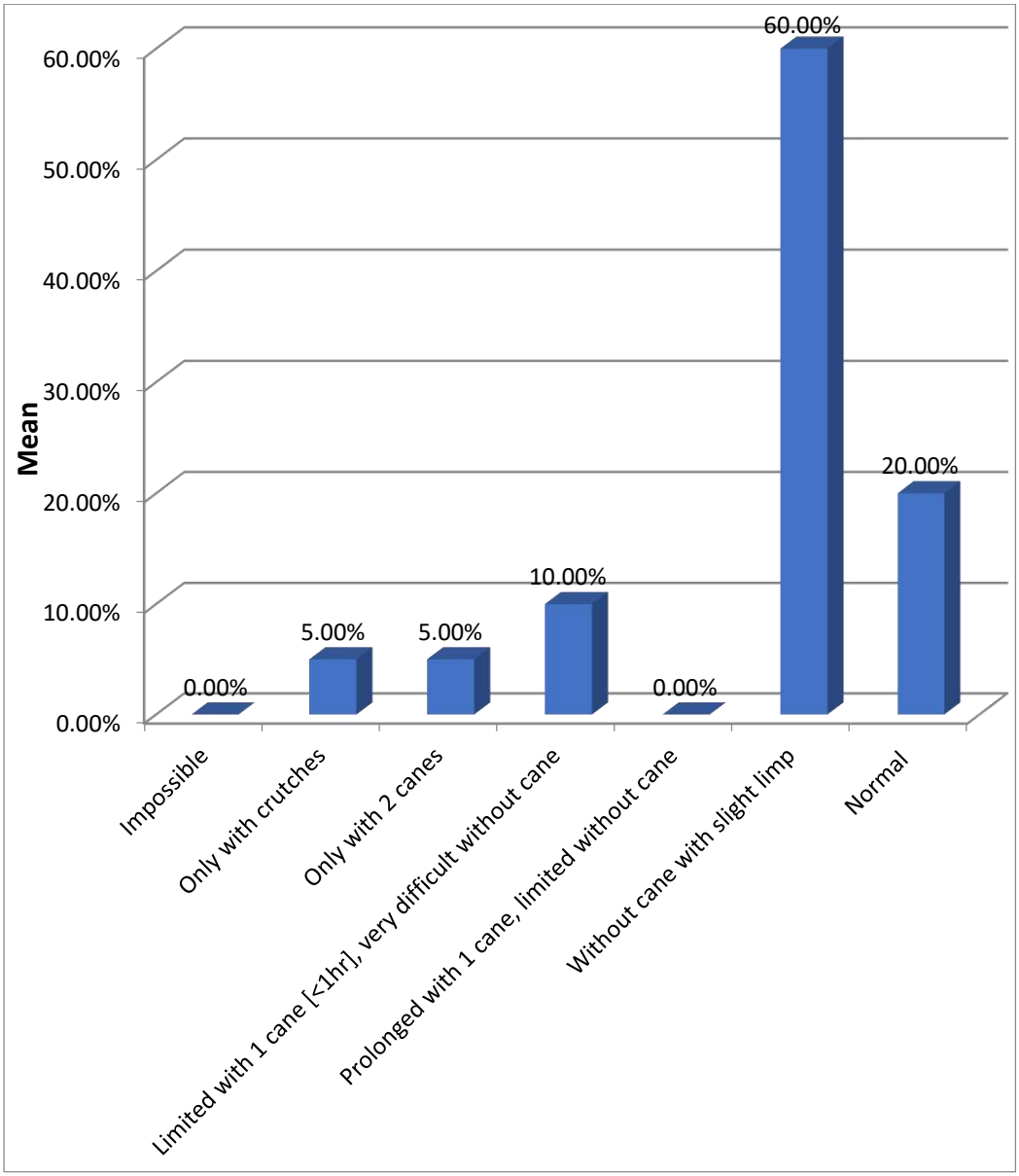


Figure 19: Distribution of the patients according to ability to walk criteria of Merle d'Aubigné and Postel score at final follow up

Table 21: Distribution of patients according to the maximum duration of follow up

	N	Minimum	Maximum	Mean	SD
MAXIMUM FOLLOW UP (MONTHS)	21	6.0	24.0	10.0	4.6

Out of the 20 total patients participating in our study, all the patients were followed up for a minimum period of six months. The mean follow up period for the study was 10 months.

DISCUSSION

The present study enrolled a total of 20 patients with acetabulum fracture (isolated transverse fracture or transverse fracture associated with anterior and/or posterior column). Complete data of 20 patients was available for compilation and analysis. Acetabulum fractures are associated with high mortality and disability rates. Emergency resuscitation and restoration of joint congruency during surgery are critical part of the treatment. Acetabulum fractures and associated injuries often trigger long term dysfunction and morbidity. Anatomical reduction and surgical fixation are required to restore joint congruency and assist patients to commence early functional physiotherapy and rehabilitation and we agree with these observations. Limited amount of Indian studies is available regarding the outcome of fixation of acetabular fractures, especially those involving transverse acetabular fractures.

Age/Sex Incidence:

In this study, 20 patients with age ranging from 15 to 75 years with a mean age of 45.5 were analysed. Out of 20 patients included in the study, 65% of the patients were in the age group pf 15 to 50 years a smost of the injuries occurred due to high speed motor vehicle accidents. Age group with the highest incidence of acetabular fractures was 20 to 40 years with incidence of 30% of the total cases followed up. Out of the 20 patients participating in the study, 15 were males and 5 were females. (male: female: 3:1). Hence there has been a higher incidence of acetabular fractures among males in our study.

Giannoudis et al., in their meta-analysis of 3670 patients of fracture acetabulum reported a mean age of patients as 38.6±4.6 years and 69.4% of them were males. [11]

Shrestha et al., in a retrospective analysis of 33 cases of acetabulum fractures treated with operative management reported 24 male and 9 female patients with average age of 39 years (range 21-65 years) in their study. [28]

Matta in his study of 262 displaced fractures of acetabulum reported the mean age of 37 years (age range of 11-90 years) with 71% patients male. [10]

We observed in our study that majority of patients were in the third and fourth decade of life with higher incidence in males as with correlation with other studies. This could be due to more outdoor activities in this age group making them more prone to these types of injuries.

Mode of injury:

Roadside accidents were the most common cause of transverse fractures of acetabulum in our study. Out of 20 patients included in the study, majority [85%, 17 patients] had roadside accident as a cause of their injuries, followed by fall from height [15%, 3 patients].

Giannoudis et al., in their meta-analysis of 3670 patients of fracture acetabulum reported road traffic accident being the causative organism in 80.5% of patients 10.7% of the cases had fall from height while the remaining 8.8% of the cases had other causes of injury. [11]

Gansslen and Krettek in their study of 27 patients of acetabular fractures reported high velocity trauma as the cause of injury in 74.1% of cases. [29]

Shrestha et al in their study of 27 patients with acetabulum fractures reported high velocity trauma as the cause of injury in 21 patients (63%). [28]

Sharma et al in their cohort study of 10 patients with acetabulum fractures reported that among 10 patients, 8 patients (80%) had road traffics accidents as the cause for injuries while 2 patients (2%) had a fall from height. [30]

Other studies have also observed that majority of acetabulum fractures are a direct result of road traffic accident. This is a cause of concern especially in a developing country like India, given the high population density in the urban areas, dramatic increase in vehicle ownership in the last few decades and poor traffic discipline.

Fracture type:

All acetabulum fractures were graded according to the Judet and Letournel classification. Out of 20 patients participating in the study,

majority [60%, 12 patients] had transverse fracture of acetabulum followed by 6 patients [30%] with bi-columnar fracture acetabulum. Remaining 2 patients [10%] had transverse fracture along with fracture of posterior wall. All 20 patients had a closed fracture of acetabulum.

Giannoudis et al in their meta-analysis 3670 fractures of acetabulum reported that the most frequent type of fracture involved, based upon Letournel classification was the posterior wall, accounting for 23.9% of all injuries. Fractures involving both columns were seen in 22% of the cases, while 3.9% of the cases had an isolated anterior column fracture. 5% of the cases had anterior column + posterior hemi-transverse acetabulum. [11]

Matta in his study of 262 displaced acetabulum fractures in 259 patients reported 54 elementary fractures of acetabulum and 208 associated acetabulum fractures according to Letournel and Judet classification. 92 fractures were associated both column fractures followed by 60 transverse fractures with posterior wall fractures. Only 12 patients out of a total of 262 patients had an isolated anterior column fracture. [10]

Associated injuries:

Out of the 20 patients included in the study, only 4 patients [20%] had isolated fractures of acetabulum while 80% had one or more associated injuries of various major organ systems. 10 out of 20 patients [50%] had associated long bone fractures and other musculoskeletal injuries. 7 patients [35%] had associated CNS/head injuries. 3 patients out of 20 had associated chest trauma along with fracture acetabulum. Majority [10 patients, 50%] of the patients had associated musculoskeletal injuries including long bone fractures of either upper or lower limbs [5 patients, 25%]. Out of 20 patients that were followed up, 2 patients had associated fracture of contralateral acetabulum. One out of twenty patients had associated fracture of ipsilateral calcaneum. One out of 20 patients had maxilla-facial injuries. Out of total 20 patients, 7 patients (35%) had hip dislocation, one out of which had foot drop resulting from associated nerve injury.

Giannoudis et al in their meta-analysis of 3670 fractures of acetabulum reported that fractures of the extremities and head injuries were the most commonly associated injuries along with complex fractures of acetabulum. Associated injuries were documented in 819 patients and included head injury in 180 patients with incidence of 22%, chest trauma in 65 patients with and incidence of 7.9%, pelvic ring trauma in 51 patients with incidence of 6.2%, musculoskeletal and long bone injury in 330 patients with incidence of 40.3 and other injuries in 46 patients with incidence of 5.6%. A total of 299 nerve injuries were recorded on admission with incidence of 16.4% with the predominant nerve injured being the sciatic nerve, except for 2 cases which involved the femoral nerve. [11]

Gansslenn and Krettek in their study of 27 patients with acetabulum fractures reported 55.5% incidence of hip displacement and major injury to sciatic nerve was present in 14.8% of cases. [29]

Shrestha et al in their prospective analysis of 33 cases of acetabulum fractures treated with operative management reported that 9 patients had dislocation of hip and 15 had concomitant other injuries at presentation. [28]

Lichte et al in their 30-year prospective study on predictors of poor outcomes of acetabular fractures reported that 60% of the patients (59.7%) suffered a high-energy trauma. Ninety eight percent of the patients had injuries in other body regions. In most of these patients (51; 46.8%) a traumatic brain injury was diagnosed, followed by thoracic (41; 37.6%) and abdominal injuries (21; 19.3%). [19]

It can be inferred from the above discussion that because of the large force that is required to disrupt the acetabulum, these injuries are indicative of high energy trauma to the patient and therefore, often associated with other injuries. These associated injuries can themselves be life threatening in addition to acetabulum fractures and can be difficult to manage without a dedicated trauma care setting with skilled trauma team and resuscitative measures. Our observation of acetabular fractures caused by road traffic accidents correlates with the pattern of the fracture and associated injuries with other studies. So,

the patients with this kind of fractures should be thoroughly examined for other associated injuries.

Surgical approach used:

Out of the total 20 cases included in the study, in majority [8 patients, 40%] underwent posterior column fixation via the Kocher-Langenback approach alone. 3 patients [15%] were operated via the ilio-inguinal approach and 3 patients [15%] were operated through the modified stoppa's approach. 4 patients [20%] out of total 20 patients were operated through combined kocher-langenback approach and ilio-femoral approach. The remaining 2 patients [10%] were operated via the combined Kocher Langenback approach and ilio-inguinal approach.

Giannoudis et al in their meta-analysis of 3670 cases of acetabulum fractures treated surgically reported Kocher-Langenback approach being used in 48.7% of the cases, ilioinguinal approach in 21.9% of cases and iliofemoral approach in 12.4% of the cases. In 17% of the patients, other surgical approaches were used including the direct lateral approach, triradiate approach and the extensile and combined approaches. [11]

Dong et al in a study of 54 patients with complex acetabular fractures treated surgically used Kocher-Langenback approach in 23 cases, anterior ilioinguinal approach in 3 cases and the combination of anterior and posterior approaches in 28 cases. [12]

Gänsslenn and Krettek in their analysis of 27 patients with both column acetabulum fractures used the ilioinguinal approach for the open reduction and fixation of the fracture and fixed the anterior column first following the proximal to distal rule and then did reduction of posterior column against the anterior column. [29]

Matta in his study of 262 displaced acetabular fractures used various approaches for the internal fixation of 259 operatively managed patients. Kocher-Langenback approach was used in 112 patients (43%); ilioinguinal approach in 87 patients (33%); extended iliofemoral approach in 59 patients (22%) and combined ilioinguinal and Kocher-Langenback approaches in 4 patients (2%). [10]

Our study is in concordance with all the above listed studies as the most common approach used for the open reduction and internal fixation of transverse fractures of acetabulum was the Kocher-Langenback approach (8 patients, 40%).

Type of implant used:

Out of the 20 patients included in our study, all 20 cases [100%] cases were fixed with pelvic reconstruction plates either through anterior approach, posterior approach or combined approach. In 12 cases out of total 20 cases [45%], 4.5mm partially threaded cancellous cannulated screws were used as lag screws. In 6 patients [30%], pelvic reconstruction plates were used along with the 3.5mm cortical screws for fracture fixation.

Rommens conducted a study over a period of 9 years on 61 patients with complex acetabular fractures which were treated with ilioinguinal approach. Fracture fixation was done with lag screws (pelvic bucket) and long contoured iliopectineal plate. [31]

Dong et al in a study of 54 patients with acetabular fractures treated surgically used AO reconstruction plates and screws for fixation of acetabular fracture in all the cases. [12]

Shazar et al in their study on Biomechanical evaluation of transverse acetabular fracture fixation followed up 40 operated cases of transverse fractures of acetabulum used AO reconstruction plates and 3.5mm lag screws in all the cases. [32]

Complications:

Of the total 20 cases included in the current study, majority [8 patients, 45%] suffered from post-traumatic arthritis. Avascular necrosis of the femoral head was seen in 2 patients out of 20 [10%]. One patient out of 20 [5%] suffered from myositis ossificans of proximal thigh. One patient had surgical site infection and discharge from the suture line which required post-operative-exploration and wound wash.

Rollman et al in their study on Predictors for secondary hip osteoarthritis after acetabular fractures followed up 678 operated cases of acetabular fractures and reported the incidence of secondary osteoarthritis in 19.8% of the total patients. [25]

Giannoudis et al in their meta-analysis of 3670 cases of acetabulum fractures treated operatively reported the incidence of OA following operatively treated acetabular fractures was 26.6%. Five years after injury 19% of patients had OA grades III or IV. The overall incidence of OA in the meta-analysis following anatomical surgical reduction was about 10%, whereas it increased to more than 30% if this quality of reduction could not be achieved. Heterotrophic ossification was reported in a total of 613 patients (25.6%) classified according to HO classification of Brooker. [11]

Radiological outcome:

Out of a total 20 patients included in the study, 9 patients (45%) had an excellent radiological result at final follow up, 9 patients (45%) had good radiological result, 1 patient (5%) had fair radiological result and 1 patient (5%) had a poor radiological result. The final follow up radiographs were graded according to the criteria developed by Matta.

Gras et al in a study conducted on outcome of operatively managed unstable acetabulum fractures in 30 patients managed with anterior intra-pelvic approach reported excellent radiological results in 50% of the total cases, goof result in 25% of cases, fair result in 11% and poor result in 14% of the cases as per Matta's grading. Excellent and good results were observed in 75% of the total cases. [33]

Dong et al in a study on surgical and radiological outcomes of 54 cases of operatively managed complex fractures of acetabulum reported good to excellent result in 80.7% of the cases. [12]

Shrestha et al in a retrospective analysis of 33 cases of operatively managed acetabular fractures reported excellent radiological outcomes in 14 cases. [29]

Bhat et al in a study conducted on 59 patients with displaced acetabular fractures reported radiological outcomes of surgery as excellent in 16% of cases, good in 54% cases, fair in 20% of cases and poor in 10% of cases. Good to excellent results were achieved in 42 cases (70%). [28]

Magu et al in their study on modified Kocher-Langenback approach for reduction of complex fractures acetabulum reported excellent

radiological result in 10 (71%) and good in three (22%) patients and fair in one (7%) patient. [14]

Iqbal et al in their study on functional and radiological outcomes of operatively managed transverse fractures of acetabulum followed up radiological outcomes of 50 patients. The patients were divided into three groups such as anatomical, congruent and incongruent group. Based on this division, 39 (78.0%) outcomes were in anatomical group, 5 (10.0%) were in congruent group and 6 (12.0%) were in incongruent group. [18]

All the above studies are in concordance with the outcomes of our current study.

Clinical outcome:

According to the Merle d'Aubigné and Postel functional outcome score, out of total 20 patients available for the final follow up, 15 patients [75%] had an excellent score, 3 patients [15%] had good score, 2 patients [10%] had a poor score. Mean Merle d'Aubigné and Postel method score at 6 months follow up was 14.10 with a standard deviation of 2.8. Out of 15 patients with excellent score, 9 patients had an excellent radiological outcome and 6 patients had good radiological outcome. Out of 3 patients with good score, 2 patients had good radiological outcome and 1 patient had fair outcome. Out of 2 patients with poor score, one patient had fair radiological outcome and the remaining 1 patient had poor radiological outcome. Two patients had concomitant same side lower limb musculoskeletal injury due to which the ability to bear weight was delayed and the patients had a low ability to walk score of Merle d'Aubigné and Postel Method. 2 patients with poor clinical outcome at the final follow up had avascular necrosis of femoral head. One patient with good clinical outcome had myositis ossificans at final follow up.

Matta in his study of 262 cases of acetabular fractures with 259 operatively managed cases reported that overall clinical results were excellent for 104 patients (40%), good for 95 patients (36%), fair for 21 patients (8%) and poor for 42 patients (16%). [10]

Gras et al in a study conducted on operative outcome in unstable acetabulum fractures in 30 patients managed with anterior intrapelvic approach reported the clinical outcome as per the Merle d'Aubigné score which was excellent in 17% of cases, good in 37%, fair in 33% and poor in 13% cases. [33]

Gansslen and Krettek in their analysis of 27 patients with both column acetabular fractures reported excellent functional outcomes according to Merle d'Aubigné score in 11 cases and good outcome in 5 cases. [29]

Giannoudis et al in their meta-analysis of 3670 fractures of acetabulum reported that a total of 16 studies (1610 patients) used the Merle d'Aubigné and Postel Method to assess the functional outcomes according to which 810 patients (50.3%) were graded as excellent, 468 patients (29.1%) as good, 138 patients (8.6%) as fair and 194 patients (12.0%) as poor. [11]

Magu et al in their study on use of Kocher-Langenback approach for reduction of complex fractures acetabulum with 14 operative cases reported excellent clinical outcome in 10 patients (71%), good in three patients (22%), and satisfactory in one patient (7%). [14]

SUMMMARY AND CONCLUSION

The aim of this study was to evaluate and determine the functional and radiological outcomes after open reduction and internal fixation of transverse fractures of acetabulum and to study the post-operative complications and failures. This study had a total of 20 patients which had transverse fractures of acetabulum either associated with anterior and/or posterior column of acetabulum managed with open reduction and internal fixation. The age ranged widely from 20 years to 60 years with mean age of 45.5 years. Majority of these patients belonged to 31-40 years age group with male preponderance. Road traffic accidents (17 patients, 85%) were the most common cause of these fractures followed by fall from height (3 patients, 15%).

All acetabulum fractures were classified according to the Letournel and Judet classification. Out of 20 patients participating in the study, majority [60%, 12 patients] had transverse fracture of acetabulum followed by 6 patients [30%] with bi-columnar fracture acetabulum. Remaining 2 patients [10%] had transverse fracture along with fracture of posterior wall. All 20 of the patients participating in the study had closed fracture type.

Out of the 20 patients included in the study, only 4 patients [20%] had isolated fractures of acetabulum while 80% had one or more associated injuries of various major organ systems. 10 out of 20 patients [50%] had associated long bone fractures and other musculoskeletal injuries. 7 patients [35%] had associated CNS/head injuries. 3 patients out of 20 had associated chest trauma along with fracture acetabulum. Majority [10 patients, 50%] of the patients had associated musculoskeletal injuries including long bone fractures of either upper or lower limbs [5 patients, 25%]. Out of 20 patients that were followed up, 2 patients had associated fracture of contralateral acetabulum. One out of twenty patients had associated fracture of ipsilateral calcaneum. One out of 20 patients had maxilla-facial injuries.

Out of the total 20 cases included in the study, in majority [8 patients, 40%] underwent posterior column fixation via the Kocher-Langenback

approach alone. 3 patients [15%] were operated via the ilio-inguinal approach and 3 patients [15%] were operated through the modified stoppa's approach. 4 patients [20%] out of total 20 patients were operated through combined kocher-langen back approach and ilio-femoral approach. The remaining 2 patients [10%] were operated via the combined Kocher-Langen back approach and ilio-inguinal approach.

Of the total 20 cases included in the current study, 8 patients [45%] suffered from post-traumatic arthritis. Avascular necrosis of the femoral head was seen in 2 patients out of 20 [10%]. One patient out of 20 [5%] suffered from myositis ossificans of proximal thigh. One patient had surgical site infection and discharge from the suture line which required post-operative-exploration and wound wash. One patient required implant removal and revision THR of the hip joint.

Out of a total 20 patients included in the study, 9 patients (45%) had an excellent radiological result at final follow up, 9 patients (45%) had good radiological result, 1 patient (5%) had fair radiological result and 1 patient (5%) had a poor radiological result. The final follow up radiographs were graded according to the criteria developed by Matta.

According to the Merle d'Aibigne and Postel functional outcome score, out of total 20 patients available for the final follow up, 15 patients [75%] had an excellent score, 3 patients [15%] had good score, 2 patients [10%] had a poor score.

We have concluded that:

Transverse fractures are associated with injuries occurring in high energy motor vehicle accidents. Operative management of these fractures results in satisfactory clinical outcomes inspite of high incidence of post traumatic arthritis. We recommend that these type of injuries require timely and aggressive emergency resuscitative management followed by fixation by adequately trained pelvi-acetabular surgeons using various methods used in our study.

Limitation of study:

The study was a short-term study with an average follow up of 10 months. The study did not have randomisation or a control group for comparison. Our cohort is small. A large, randomised, controlled and multicentric study shall be helpful to make a meaningful conclusion.

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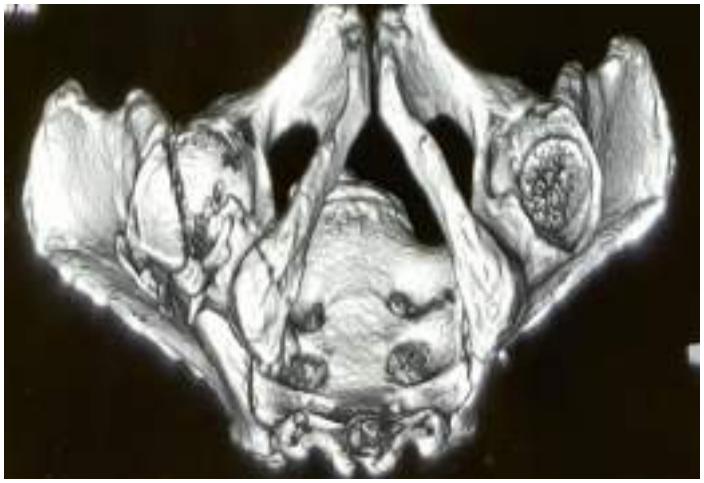
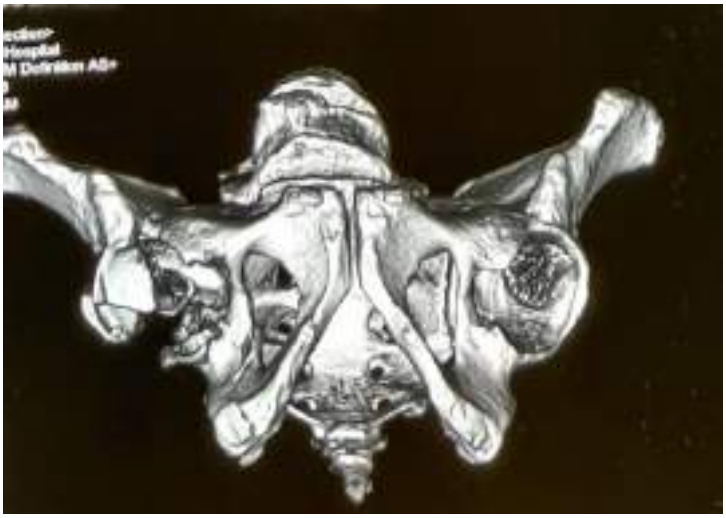
CASE 1

PRE- OP





POST OP

FINAL FOLLOW UP

CASE 2

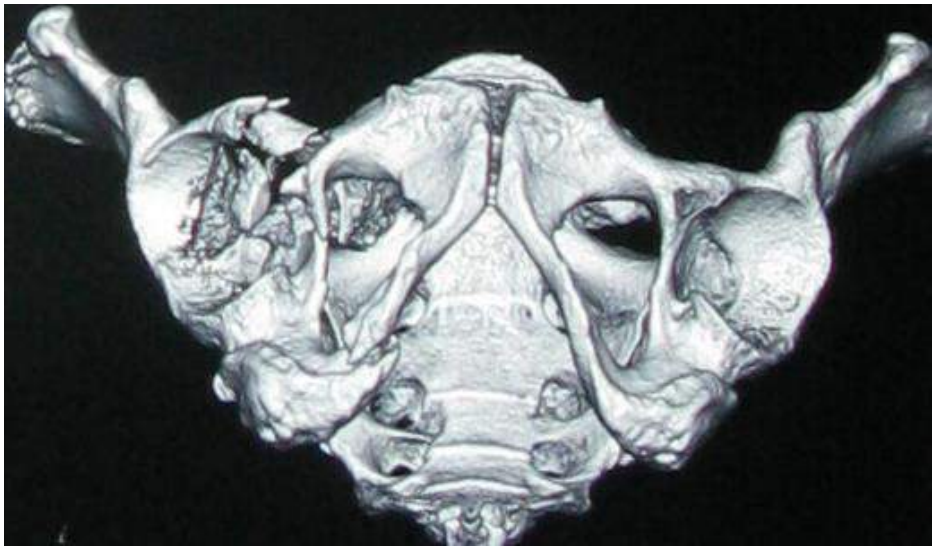
PRE-OP

POST OP

FINAL FOLLOW UP

CASE 3

PRE-OP



POST OP

FINAL FOLLOW UP

CASE 4

PRE-OP

POST OP

FINAL FOLLOW UP

CASE 5

PRE-OP

POST OP

FINAL FOLLOW UP

S.No.	NAMES	MRD No	AGE	SEX	OCCUPATION	DATE OF INJURY	DATE OF ADMISSION	DATE OF DISCHARGE	DATE OF OPERATION/PROCEDURE	X RAY FINDINGS (Letournel & Judet classification)	ASSOCIATED INJURIES		
											CHEST	CNS	ABDOMEN
1	ML	176497	58	M	BUSINESSMAN	3/16/2018	3/16/2018	3/29/2018	3/21/2018	BI-COLUMNAR FRACTURE + FRACTURE POSTERIOR WALL	NONE	BLADDER INJURY	NONE
2	L	568393	17	F	STUDENT	8/26/2018	8/26/2018	9/3/2018	8/27/2018	TRANSVERSE FRACTURE + POSTERIOR COLUMN FRACTURE	NONE	NONE	NONE
3	IS	199390	56	M	RETIRED	2/11/2017	2/11/2017	2/20/2017	2/16/2017	BI-COLUMNAR FRACTURE + ROOF FRACTURE	BLUNT TRAUMA CHEST	SDH	NONE
4	TS	693985	55	M	FARMER	3/21/2019	3/22/2019	4/1/2019	3/25/2019	BI-COLUMNAR FRACTURE	NONE	NONE	NONE
5	JK	687521	52	F	HOUSEWIFE	3/12/2019	3/12/2019	3/19/2019	3/13/2019	TRANSVERSE FRACTURE + ANTERIOR COLUMN FRACTURE	NONE	NONE	NONE
6	RR	538364	47	F	HOUSEWIFE	7/14/2018	7/14/2018	7/25/2018	7/16/2018	BICOLUMNAR FRACTURE	NONE	NONE	NONE
7	GS	85982	42	M	JOB	2/11/2018	2/11/2018	2/20/2018	2/13/2018	TRANSVERSE FRACTURE + ILIAC BLADE FRACTURE	NONE	NONE	NONE
8	AS	636678	36	M	FARMER	12/12/2018	12/12/2018	2/8/2019	12/26/2018	TRANSVERSE FRACTURE + POSTERIOR WALL FRACTURE	RIB FRACTURES	NONE	NONE
9	H	570730	22	M	BUSINESSMAN	8/29/2018	8/29/2018	9/20/2018	9/1/2018	BI-COLUMNAR RACTURE	NONE	SAH + SDH	NONE
10	LR	631840	54	M	RETIRED	10/4/2017	10/4/2017	10/16/2017	10/13/2017	T-TYPE FRACTURE ACETABULAM	NONE	NONE	BLUNT TRAUMA ABDOMEN
11	JS	328662	64	M	BUSINESSMAN	8/14/2017	8/15/2017	9/1/2017	8/24/2017	BI-COLUMNAR FRACTURE			NONE
12	CS	560868	64	M	FARMER	8/15/2018	8/15/2018	9/3/2018	8/18/2018	TRANSVERSE FRACTURE	NONE	HAEMORRHAGIC CONTUSIONS	NONE
13	AS	188597	45	M	STUDENT	3/13/2019	3/14/2019	3/18/2019	3/15/2019	TRANSVERSE + POSTERIOR WALL	BLUNT TRAUMA CHEST	-	-
14	SK	359259	35	F	HOUSEWIFE	9/28/2017	9/29/2017	10/12/2017	10/3/2017	TRANSVERSE FRACTURE + POSTERIOR WALL FRACTURE	NONE	NONE	NONE
15	S	515903	26	M	JOB	6/6/2018	6/7/2018	6/27/2018	6/19/2018	TRANSVERSE FRACTURE ACETABULAM RIGHT SIDE	NONE	SAH + SDH	HAEMOPERITONIUM + LIVER INJURY
16	SS	215324	65	M	FARMER	3/4/2017	3/5/2017	3/23/2017	3/10/2017	BI-COLUMNAR FRACTURE	NONE	NONE	MILD HEMOPERITONIUM
17	SK	681665	36	M	BUSINESSMAN	3/2/2019	3/3/2019	3/13/2019	3/6/2019	BI-COLUMNAR FRACTURE	BLUNT TRAUMA CHEST	NONE	BLUNT TRAUMA ABDOMEN + LIVER INJURY
18	RK	693164	75	F	HOUSEWIFE	3/20/2019	3/21/2019	3/30/2019	3/22/2019	TRANSVERSE FRACTURE + POSTERIOR WALL FRACTURE	NONE	NONE	BLUNT TRAUMA ABDOMEN
19	SS	650579	68	M	UNEMPLOYED	1/9/2019	1/9/2019	1/24/2019	1/9/2019	BI-COLUMNAR FRACTURE	NONE	NONE	NONE
20	VK	644302	21	M	STUDENT	12/27/2018	12/27/2018	1/3/2019	12/28/2018	BI-COLUMNAR FRACTURE LEFT ACETABULUM	NONE	NONE	NONE

S.No.	NAMES	MRD No	OTHERS/MUSCULOSKELETAL INJURIES	MODE OF INJURY	EMPLOYMENT STATUS	OPEN/ CLOSED FRACTURE	LOCAL EXAMINATION		GA/Spinal Anaesthesia	TYPE OF FIXATION	DATE OF SURGERY
							X RAY FINDINGS				
							Fracture classification (AO Classification)	Hip dislocation			
1	ML	176497	NONE	RSA	WORKING/DESK JOB	CLOSED	62-B2	-	GA	ORIF	3/21/2018
2	L	568393	CALCANEUM FRACTURE RIGHT SIDE	FALL FROM HEIGHT	WORKING	CLOSED	62-B1	POSTEROSUPERIOR	GA	ORIF	3/22/2018
3	IS	199390	NONE	RSA	RETIRED	CLOSED	62-B1	CENTRAL	GA	ORIF	3/23/2018
4	TS	693985	NONE	RSA	WORKING	CLOSED	62-B1	POSTERO-SUPERIOR	GA	ORIF	3/24/2018
5	JK	687521	NONE	RSA	WORKING	CLOSED	62-B2	POSETRIOR	CSE	ORIF	3/25/2018
6	RR	538364	FRSCTURE BOTH BONE LEG RIGHT SIDE	RSA	NOT WORKING	CLOSED	62-B1	CENTRAL	GA	ORIF	3/26/2018
7	GS	85982	CLOSED FRACTURE PROXIMAL TIBIA RIGHT SIDE	RSA	WORKING	CLOSED	62-B1	-	GA	ORIF	3/27/2018
8	AS	636678	CLOSED FRACTURE PROXIMAL TIBIA LEFT SIDE + SCIATIC NERVE PALSY + FRACTURE SHAFT FEMUR RIGHT SIDE	RSA	NOT WORKING	CLOSED	62-B1	POSTERIOR	CSE	ORIF	3/28/2018
9	H	570730	FRACTURE SCAPHOID +PERILUNATE DISLOCATION	RSA	WORKING	CLOSED	62-B1		CSE	ORIF	3/29/2018
10	LR	631840	FACIAL FRACTURES OPERATED BY PLASTIC SURGERY TEAM	RSA	WORKING	CLOSED	62-B2	-	GA	ORIF	3/30/2018
11	JS	328662	OPEN GRADE II FRACTURE ULNA RIGHT SIDE	RSA	WORKING	CLOSED	62-B2	-	GA	ORIF	3/31/2018
12	CS	560868	NONE	FALL FROM HEIGHT	WORKING	CLOSED	62-B2	CENTRAL	GA	ORIF	4/1/2018
13	AS	188597	-	RSA	WORKING	CLOSED	62-B1	POSTERO-SUPERIOR	GA	ORIF	4/2/2018
14	SK	359259	NONE	RSA	WORKING	CLOSED	62-B1	-	CSE	ORIF	4/3/2018
15	S	515903	FRACTURE ANTERIOR COLUMN C/L ACETABULUM	FALL FROM HEIGHT	WORKING	CLOSED	62-B1	-	GA	ORIF	4/4/2018
16	SS	215324	OPEN FRACTURE BOTH BONE LEG RIGHT SIDE	RSA	WORKING	CLOSED	62-B1	CENTRAL	GA	ORIF	4/5/2018
17	SK	681665	NONE	RSA	WORKING	CLOSED	62-B2	CENTRAL	GA	ORIF	4/6/2018
18	RK	693164	FRACTURE INFERIOR PUBIC RAMI	RSA	WORKING	CLOSED	62-B1	CENTRAL	CSE	ORIF	4/7/2018
19	SS	650579	NONE	RSA	WORKING	CLOSED	62-B3	CENTRAL	CSE	ORIF	4/8/2018
20	VK	644302	NONE	RSA	WORKING	CLOSED	62-B2	-	GA	ORIF	4/9/2018

S.No.	NAMES	MRD No	OPERATION/PROCEDURE		COMPLICATIONS			Additional procedures			Follow up				
			APPROACH	IMPLANT TYPE	Intra-op	Post-op	Delayed	Revision and bone grafting	Debridement and irrigation	Others	Radiological union	FLEXION			
												4 WEEKS	3 MONTHS	6 MONTHS	4 WEEKS
1	ML	176497	KL APPROACH + TROCHANTERIC OSTEOTOMY	2 RC PLATES + SOLID 3.5MM SCREWS	-	-	POST TRAUMATIC ARTHRITIS	-	-	-	UNITED	60	80	100	5
2	L	568393	KL APPROACH + ILIOINGUINAL APPROACH	2 PELVIC RC PLATES + 3.5 MM SOLID SCREW	-	-	-	-	-	-	UNITED	30	60	70	0
3	IS	199390	ILIOINGUINAL APPROACH + KL APPROACH	2 PELVIC RC PLATES	-	-	POST TRAUMATIC ARTHRITIS	-	-	-	UNITED	45	60	80	0
4	TS	693985	ILIOINGUINAL APPROACH	1 PLEVIC RC PLATE + 3.5MM CC SCREW	-	-	POST TRAUMATIC ARTHRITIS	-	-	-	NON UNITED	30	50	50	0
5	JK	687521	KL APPROACH	RC PLATE	-	-	-	-	-	-	UNITED	30	40	30	0
6	RR	538364	KL APPROACH + ILIOINGUINAL APPROACH	3 PELVIC RC PLATES	-	-	POST TRAUMATIC ARTHRITIS	-	-	-	UNITED	70	110	110	5
7	GS	85982	ILIOINGINAL APPROACH + KL APPROACH	2 PELVIC RC PLATES + 3.5 MM SOLID SCREW	-	-	-	-	-	-	UNITED	60	80	100	5
8	AS	636678	KL APPROACH + TROCHANTERIC OSTEOTOMY	2 RC PLATES + SOLID 3.5MM SCREWS	-	-	SCIATIC NERVE PALSY	-	-	-	UNITED	20	20	50	0
9	H	570730	KL APPROACH	2 RC PLATES	-	-	-	-	-	-	UNITED	45	60	90	5
10	LR	631840	KL APPROACH	2 PELVIC RC PLATES	-	-	-	-	-	-	UNITED	60	70	90	5
11	JS	328662	KL APPROACH	RC PLATE	-	-	-	-	-	-	UNITED	60	70	90	5
12	CS	560868	KL APPROACH + ILIOINGUINAL APPROACH	2 PELVIC RC PLATES	-	DISCHARGE FROM SUTURE LINE	-	-	43337	-	UNITED	70	90	120	5
13	AS	188597	KL APPROACH + ILIOINGUINAL APPROACH	1 RC PLATE	-	-	-	-	-	-	UNITED	45	60	90	5
14	SK	359259	KL APPROACH + ILIOINGUINAL APPROACH	2 PELVIC RC PLATES	-	-	-	-	-	-	UNITED	45	70	90	0
15	S	515903	KL APPROACH + ILIOINGUINAL APPLROACH	2 PELVIC RC PLATES	-	-	-	-	-	-	UNITED	20	20	30	0
16	SS	215324	KL APPROACH + ILIOINGUINAL APPROACH	3 PELVIC RC PLATES + 3.5MM SOLID SCREWS	-	-	-	-	-	-	UNITED	40	60	90	0
17	SK	681665	KL APPROACH + MODIFIED STOPPA APPROACH	3 PELVIC RC PLATES	-	-	MYOSITIS OSSIFICANS (PROXIMAL FEMUR)	-	-	-	UNITED	50	60	90	0
18	RK	693164	KL APPROACH	2 PELVIC RC PLATES	-	-	-	-	-	-	UNITED	45	60	70	0
19	SS	650579	KL APPROACH + TROCHANTERIC OSTEOTOMY	2 PELVIC RC PLATES + 3.5 MM SOLID SCREW	-	-	-	-	-	-	UNITED	20	50	90	5
20	VK	644302	KL APPROACH	1 PELVIC RC PLATE	-	-	-	-	-	-	UNITED	30	50	90	5

S.No.	NAMES	MRD No	RANGE OF MOTION AT HIP JOINT														FUNCTION TO PREINJURY LEVEL				
			EXTENSION		EXTERNAL ROTATION			INTERNAL ROTATION			ADDUCTION			ABDUCTION			WEIGHT BEARING			RETURN TO OCCUF	
			3 MONTHS	6 MONTHS	4 WEEKS	3 MONTHS	6 MONTHS	4 WEEKS	3 MONTHS	6 MONTHS	4 WEEKS	3 MONTHS	6 MONTHS	4 WEEKS	3 MONTHS	6 MONTHS	4 WEEKS	3 MONTHS	6 MONTHS	4 WEEKS	3 MONTHS
1	ML	176497	10	10	20	30	30	30	30	30	20	30	30	30	40	40	NO	YES	YES	NO	YES
2	L	568393	5	5	10	20	20	15	20	30	10	10	20	20	20	20	NO	NO	YES	NO	YES
3	IS	199390	5	5	15	20	30	20	30	30	10	20	30	20	30	20	NO	NO	YES	NO	NO
4	TS	693985	5	5	10	10	10	20	20	25	10	10	10	30	30	30	NO	NO	YES	NO	NO
5	JK	687521	0	0	10	20	10	20	30	20	0	10	10	0	10	10	NO	NO	NO	NO	NO
6	RR	538364	10	10	30	40	40	40	40	40	20	20	30	30	40	40	NO	YES	YES	NO	NO
7	GS	85982	10	10	30	40	40	40	40	40	20	20	20	20	30	30	NO	YES	YES	NO	YES
8	AS	636678	5	5	10	10	10	0	0	0	0	0	0	0	5	5	NO	NO	yes	NO	NO
9	H	570730	5	5	15	20	30	20	30	40	10	20	20	20	20	30	NO	NO	-30	NO	NO
10	LR	631840	5	5	20	30	30	20	30	30	10	20	20	20	30	40	NO	YES	YES	NO	YES
11	JS	328662	5	5	15	20	30	20	30	40	10	10	20	20	30	30	NO	YES	YES	NO	NO
12	CS	560868	10	10	30	40	40	30	40	40	20	30	30	30	40	40	NO	NO	YES	NO	YES
13	AS	188597	5	10	30	30	40	30	30	45	10	15	25	20	30	45	NO	NO	YES	NO	YES
14	SK	359259	5	5	20	30	30	20	30	30	10	10	20	20	30	30	NO	YES	YES	NO	YES
15	S	515903	0	5	0	0	5	0	5	5	5	10	10	5	10	10	NO	NO	YES	NO	NO
16	SS	215324	5	5	20	30	30	20	30	40	10	20	20	15	20	30	NO	YES	YES	NO	YES
17	SK	681665	5	5	20	20	30	20	30	40	10	10	20	10	20	30	NO	YES	YES	NO	YES
18	RK	693164	5	5	15	20	20	20	30	30	10	15	20	20	20	20	NO	NO	YES	NO	NO
19	SS	650579	10	20	15	20	30	20	30	40	10	20	20	10	30	30	NO	YES	YES	NO	YES
20	VK	644302	10	15	10	30	30	10	20	30	10	10	10	10	30	30	NO	YES	YES	NO	YES

S.No.	NAMES	MRD No	ATION										Merle d'Aubigné and Postel score at final follow up	MAXIMUM FOLLOW UP (MONTHS)
				4 weeks	3 Months	6 Months	4 weeks	3 Months	6 Months	4 weeks	3 Months	6 Months		
			6 MONTHS	Mobility of the hip			Pain			Ability to walk				
1	ML	176497	YES	2	4	**5**	2	4	**5**	1	5	**5**	15	24
2	L	568393	YES	1	4	**6**	2	3	**5**	2	3	**5**	16	8
3	IS	199390	YES	2	3	**4**	3	3	**3**	2	4	**5**	12	8
4	TS	693985	YES	2	4	**3**	2	3	**4**	1	4	**5**	12	8
5	JK	687521	YES	2	2	**5**	2	3	**6**	2	4	**5**	16	6
6	RR	538364	YES	2	4	**5**	2	3	**5**	1	3	**5**	15	18
7	GS	85982	YES	1	3	**3**	1	4	**5**	1	3	**6**	14	9
8	AS	636678	NO	2	3	**3**	1	2	**3**	0	0	**1**	7	14
9	H	570730	YES	2	5	**4**	2	5	**6**	3	6	**6**	16	8
10	LR	631840	YES	2	5	**6**	2	5	**6**	3	5	**5**	17	8
11	JS	328662	YES	2	5	**6**	3	5	**5**	1	4	**5**	16	12
12	CS	560868	YES	1	3	**5**	0	1	**2**	2	4	**5**	12	12
13	AS	188597	YES	2	5	**5**	2	4	**6**	1	3	**6**	17	12
14	SK	359259	YES	4	5	**6**	2	3	**6**	0	1	**5**	17	0
15	S	515903	NO	1	2	**2**	1	2	**3**	0	0	**2**	7	6
16	SS	215324	YES	1	3	**5**	2	4	**5**	0	2	**5**	15	15
17	SK	681665	YES	2	4	**5**	1	2	**2**	0	1	**3**	10	8
18	RK	693164	YES	2	4	**5**	2	4	**5**	1	2	**3**	13	8
19	SS	650579	YES	2	4	**6**	2	5	**6**	2	6	**5**	17	6
20	VK	644302	YES	2	5	**5**	2	5	**4**	3	6	**6**	15	6

Baba Farid University
of Health Sciences
Sadiq Road
Faridkot-151 203 (Pb). INDIA.
Phone : 01639-256232,256236
Tele/Fax : 01639-256235
Email – Examination@bfuhs.ac.in

No. BFUHS/2K18p-TH/ 14154 **Date** 4/10/18

The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 31.08.2018 has approved the plan of thesis of Dr. Amtoj Singh Khara, a student of your college for **MS Orthopaedics** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Clinical and radiological outcomes in surgically managed patients of transverse fractures of acetabulum

Supervisor
Dr. Harpal Singh Selhi
Prof.,
Dept. of Orthopaedics,
DMCH, Ludhiana.

Co-Supervisor
Dr. Deepak Jain
Assoc. Prof.,
Dept. of Orthopaedics,
DMCH, Ludhiana..

The student may submit the four copies of thesis, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this letter with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

SP Singh

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
2. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SURGERY

IN

ORTHOPAEDICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

(JANUARY, 2018)

DR. AMTOJ SINGH KHARA

DEPARTMENT OF ORTHOPAEDICS

DAYANAND MEDICAL COLLEGE AND HOSPITAL, LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM
For the degree of	MS Orthopaedics
Name of the candidate	Dr. Amtoj Singh Khara
Supervisor	Dr. Harpal Singh Selhi, Professor, Department of Orthopaedics, DMCH, Ludhiana
Co-supervisor(s)	Dr. Deepak Jain, Associate Professor, Department of Orthopaedics, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Transverse fractures of acetabulum are a challenge for the orthopaedic trauma surgeons to manage. Recent advances in surgery techniques have led to surgical fixation of acetabular fractures instead of conservative management. The purpose of this study is to evaluate the outcomes of operatively managed patients of transverse fractures of acetabulum and associated complications.

Aims & Objectives: Clinical and radiological outcomes in surgically managed patients of transverse fractures of acetabulum

Material & Methods: Study will be conducted on inpatients in department of orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana from January 2016 to January 2019 who have given valid informed consent to take part in the study. A structured pre designed proforma will be used for this study.

Clinical Significance: Post-operative cases of acetabular fractures are associated with various early and delayed complications such as infection, hemorrhage, iatrogenic nerve injuries, deep vein thrombosis, heterotrophic ossification.

Keywords: Transverse Fractures, Acetabulum, Hip dislocation

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM"** exist in the Department of Orthopaedics, DMC&H, Ludhiana, and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

SUPERVISOR:

DR. Harpal Singh Selhi
Professor
Department of Orthopaedics
DMC&H, Ludhiana

CO-SUPERVISOR:

DR. Deepak Jain
Associate Professor
Department of Orthopaedics
DMC&H, Ludhiana

DR. Rajnish Garg
Professor & Head
Department of Orthopaedics
DMCH, Ludhiana

Place: Ludhiana

Date: 18/1/18

APPROVAL PROFORMA
BY RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. AMTOJ SINGH KHARA
Department	ORTHOPAEDICS
Topic of Thesis	CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM
Likely date of appearing in PG examination	JUNE 2020
Date of enrollment	31.05.2017
Name of Head of Department	DR. RAJNISH GARG
1. Supervisor 2. Co-Supervisor	DR. HARPAL SINGH SELHI DR. DEEPAK JAIN
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
1. HOD Pharmacology	1. HOD Physiology
2. HOD Surgery	2. HOD Pathology
3. HOD Pathology	3. HOD Pharmacology
4. HOD Medicine	4. HOD SPM
5. Dean Academics	5. HOD Medicine
6. Vice Principal	7. HOD Surgery
	7. HOD Obst. & Gynae.
	8. Legal Expert
	9. Secretary, IEC
	10. Dean Academics
	11. Vice Principal
	12. Principal

Approved: Yes / No

Chairperson
Research Committee

Chairperson
Research Committee

Approved: Yes / No

Chairperson
Ethics Committee

Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	DR AMTOJ SINGH KHARA H. NO. 59-C, RAJGURU NAGAR, LUDHIANA-141012, PUNJAB.
2	NAME OF THE INSTITUTE	Dayanand Medical College and Hospital, Ludhiana
3	COURSE OF STUDY AND SUBJECT	MASTER OF SURGERY ORTHOPAEDICS
4	DATE OF ADMISSION OF COURSE	31.05.2017
5	TITLE OF THE TOPIC	CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Acetabulum fractures remain a big challenge to radiologists and orthopaedic trauma surgeons for the diagnosis and management. These fractures are potentially a life-threatening condition, typically caused by high energy trauma in younger individuals and associated with multi-system injuries. Incidence of acetabulum fractures is approximately 3 per one lakh individuals. Out of all the types of acetabular fractures, transverse acetabular fracture contributes to 5% to 19% of the total. The transverse fracture is an elementary type fracture of the acetabulum. It consists of a single fracture line that traverses both the anterior and posterior columns of the acetabulum. The fracture line separates the innominate bone into the superior iliac segment and the inferior ischio-pubic segment.

Earlier, the primary line of management of acetabular fractures was conservative with closed reduction and skin/skeletal traction. But, these methods failed to achieve and maintain complete anatomical reduction and joint congruity leading to complications like osteoarthritis of the hip joint, avascular necrosis of head of femur and postural/gait disturbances. The development of newer diagnostic tools like MDCT has helped us to minutely analyse the three-dimensional disturbance in the normal anatomy and plan the surgical management accordingly.

In the present era, surgery has become the treatment of choice for management of transverse fractures of acetabulum as accurate anatomical reduction and adequate internal fixation can be attained. These fractures can be fixed with anterior column plating only, posterior column plating only,

anterior column plating combined with posterior column screw fixation, posterior column plating and anterior column screw fixation or bi-columnar plating depending upon the nature and severity of the fracture. It helps in early pain relief, early mobilization and fracture union as compared to conservative treatment. But, these are associated with complications such as infection, haemorrhage, iatrogenic nerve injuries, deep vein thrombosis, heterotrophic ossification. Despite these complications, we can achieve the reduction of fracture with less than 2 mm displacement. This decreases the incidence of post traumatic osteoarthritis of the hip joint.

The objective of our study is to evaluate the functional and radiological outcomes of operatively managed transverse acetabular fractures.

6.2 REVIEW OF LITERATURE

Giannoudis et al [2005] conducted a study showing how it is important, at operation, to obtain the most accurate reduction of the fracture which is possible, with a minimal surgical approach, as both influence the outcome.[1]

Gänsslen at al., [2009], exhibited the open anatomic reduction and stable internal fixation of both-column acetabular fractures by screw and plate osteosynthesis via the ilioinguinal appoach with excellent and good functional results according to the Merle d'Aubigné Score.[2]

Magu et al [2016] displayed that modified K-L approach may be a good alternative for the standard K-L approach in the management of elementary fractures and associated fractures of the acetabulum when combined with an anterior surgical approach. The authors concluded that modified K-L approach made the procedure less invasive, shortened the operative time, minimized the blood loss and overcame the exhaustion and fatigue of the surgical team. [3]

Shrestha et al [2014] in their study decided that acetabular fractures were effectively managed with open reduction and internal fixation and had predictable and comparable functional and radiographic outcomes. Upgrading the existing facilities and training of orthopedic surgeon for acetabular fracture management was important to shorten injury-surgery interval due to lack of such facilities.[4]

A study by Boraiah et al [2009] presented that a less extensile approach and single surgery with open reduction and internal fixation and acute THA can have good outcomes. Restoration of acetabular bone stock was the major prognostic factor that may improve the outcome. The value of open reduction

and internal fixation in restoring bone stock and minimizing pelvic deformity was described with a mean Harris hip score of 88 points and no radiographic evidence of implant migration in this elderly population. Boraiah believed that acetabular open reduction and internal fixation and acute THA seems to be a promising option in selected cases.[5]

Herscovici et al [2010] in there study presented a different approach for acute acetabular fractures in the elderly. The authors showed the surgical approach was one of aggressive management to stabilize the pelvic injury, which decreased pelvic deformities and prevented bone loss, while performing an acute (Total Hip Replacement) THA. These patients underwent a single surgical procedure and avoided the wait for a future THA resulting from a painful joint as a result of the development of avascular necrosis or post-traumatic arthritis of the hip.[6]

Xu et al., [2017] in their study on Treatment of Transverse with or without posterior wall fractures of acetabulum using a modified Smith-Petersen combined with Kocher-Langenbeck approach concluded that for transverse with or without posterior wall fractures of the acetabulum, reduction and fixation of anterior and posterior column should be done in sequence, and a modified Smith-Petersen small incision might be a good choice in reduction and fixation of the anterior column under direct visualization.[7]

Ovre et al., in their study on differences between fractures with a large posterio-superior fragment and the inverse T-fracture submitted that open reduction and internal fixation of inverse T-fractures and transverse fractures with a floating dome require different surgical approaches. The latter can be

treated through a single approach alone, while the inverse T-fracture may require extensile or combined approaches for adequate reduction and fixation.[8]

Sagar et al., [2015] in their study on Functional outcome of surgical management of acetabular fractures by internal fixation concluded that anterior column fractures are managed effectively by Ilioinguinal approach and the Posterior column fractures by the Kocher-Langenbeck approach. In Bicolumnar fractures, one column is first fixed and assessed for the reduction of the other column. If the latter is not reduced then that column is also fixed with the appropriate approach. Complications of acetabular fractures treated operatively are minimal. Good to excellent results were achieved in 76.4% patients.[9]

Finite element analysis of the stability of transverse acetabular fractures in standing and sitting positions by different fixation options was studied by Yildrim et al., in 2015. They observed that posterior column plating combined with an anterior column screw has quite comparable results to a both column plating in transverse fractures. Further, this method is also superior to anterior column plating combined with a posterior column screw in transverse fractures and may allow earlier sitting and standing during rehabilitation. The authors opined that two column fixation was not necessary in transverse type of fractures.[10]

Iqbal et al., [2016] in their study on fucntional and radiological outcome of surgical management of acetabular fractures in tertiary care Hospital concluded that mechanism of injury, time between injury and surgery, initial degree of displacement and quality of reduction had significant effect on

functional as well as radiological outcome. In the authors' opinion, with the availability of good imaging facilities, surgeon experience, better instrumentation along with good perioperative care, the surgical fixation of displaced acetabular fractures would yield better results.[11]

Giordano et al., [2009] in their study on operative treatment of transverse acetabular fractures suggested that associated transverse-posterior wall acetabular fractures can be managed by a single posterior approach. Direct reduction and fixation of the posterior wall and column components is an adequate option for these injuries. In their opinion, the authors observed that it was not necessary to fix the anterior column component of the transverse fracture.[12]

Lichte et al., [2013] in their study on predictors of poor outcomes of transverse acetabular fractures established that anatomical reduction appears to be an important parameter for a good clinical outcome in patients with both column acetabular fractures. Additional fracture characteristics such as the initial displacement and intraarticular fragments seem to influence the radiological and functional outcomes.[13]

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To evaluate the hip function of operatively managed transverse acetabular fracture.
- To evaluate reduction on radiology
- To study the complications of operative fixation of transverse acetabular fractures.

7. MATERIALS AND METHODS

7.1 SOURCE OF DATA

Patients in department of orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana from January 2016 to January 2019 who have given valid informed consent to take part in the study.

7.2 METHOD OF COLLECTION OF DATA

A. Methodology and type of data collected:

After obtaining clearance and approval from the institutional ethical committee, patients fulfilling the inclusion / exclusion criteria will be included in the study after obtaining informed consent.

Detailed history will be obtained using study proforma with special attention to mechanism of injury, evaluations including base line clinical features, examination of other associated symptoms will be based on history and physical examination.

Collection of data of patients presenting with transverse fracture of acetabulum are as follows.

- History.
- Clinical examination both systemic and local.
- Radiological examination using X ray, CT (computerized tomography) scan and other imaging modalities if necessary.
- Investigations – Routine and others.
- Diagnosis- Clinical and radiological.
- Surgery- open reduction and internal fixation of transverse fracture of acetabulum.
- Routine antibiotics and analgesics/anti-inflammatory drugs.

- DVT prophylaxis

- Post operative evaluation by clinical examination and X ray pelvis (AP view, iliac oblique view, obturator oblique view)

Surgical approaches:

- Kocher Langenback approach
- Ilioinguinal approach
- Modified stoppa's approach

Assessment of complications.

- **Perioperative** –difficulty in reduction, hypotension, shock, hemorrhage, nerve injury, vascular injury, inability to reduce the hip.
- **Immediate post-operative** –Acute Renal Failure (ARF), pulmonary embolism, fat embolism, cardiovascular compromise (MI, ACS), infection, loss of reduction, DVT
- **Late post-operative** -infection, nonunion, malunion, failed fixation, osteoarthritis of hip joint, avascular necrosis of the femoral head, dislocation of femoral head, metal work failure

Clinical follow-up will be done at 4 weeks, 3 months, 6 months intervals to assess the pain, healing of fracture, and functional status of the hip.

Radiological follow up by X ray will be done at 4 weeks, 3 months, 6months, to assess the reduction and healing status of the hip.

B. Inclusion Criteria:

1. Transverse fractures of acetabulum (may or may not be associated with anterior or posterior wall fracture of acetabulum)
2. Age group 18 to 70 years of either sexes.
3. Patients who give informed consent and willing for follow up.

C. Exclusion Criteria:

1. Patients less than 18 years of age.
2. Patients unfit for surgery.
3. Pregnant patients
4. Open fractures
5. Pathological fractures
6. Patients managed conservatively
7. Patients managed with hip replacement
8. Fracture > 3 weeks old at the time of surgery

D. Study design: Prospective & Retrospective

E. Study duration: 3 Years

F. Place of study: Inpatients in Department of Orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana.

OUTCOME

Final radiological and functional outcome at six months follow up using Merle d'Aubigné- Postel Scores.

STATISTICAL ANALYSIS

The data collected will be recorded in a pro forma and will be analysed using appropriate observational statistical methods.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

- Investigations : Routine and others if required.
- Radiological examination using X ray, CT scan and other imaging modalities if necessary.

7.4 HAS THE ETHICAL CLEARANCE BEEN OBTAINED FROM ETHICAL COMMITTEE OF YOUR INSTITUTION IN CASE OF 7.3?

YES.

8. LIST OF REFERENCES

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9. Anizar-Faizi A, Hisam A, Sudhagar K, Moganadass M, Suresh C. Outcome of Surgical Treatment for Displaced Acetabular Fractures. Malays Orthop J. 2014;8(3):1-6.

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11. Iqbal F, Taufiq I, Najjad MKR, Khan N, Zia OB. Functional and Radiological Outcome of Surgical Management of Acetabular Fractures in Tertiary Care Hospital. Hip Pelvis. 2016;28(4):217-24.

12. Giordano V, do Amaral NP, Pallottino A, Albuquerque RP, Franklin CE, Labronici PJ. Operative treatment of transverse acetabular fractures: is it really necessary to fix both columns? Int J Med Sci. 2009;6(4):192-9.

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PROFORMA

S.No. NAME: AGE: SEX:

ADM No: MRD No:

FATHER'S /HUSBAND'S NAME:

ADDRESS:

OCCUPATION:

DATE OF INJURY:

DATE OF ADMISSION:

DATE OF DISCHARGE:

DATE OF OPERATION/PROCEDURE:

MODE OF INJURY: ROAD SIDE ACCIDENT/MOTOR VEHICLE ACCIDENT

EMPLOYMENT STATUS – WORKING/NOT WORKING

LOCAL EXAMINATION

OPEN /CLOSED FRACTURE:

X RAY FINDINGS:

- Fracture classification (AO Classification):
- Site of fracture:
- Hip dislocation:

Signature of candidate **Signature of supervisor**

OPERATION/PROCEDURE:

ANAESTHESIA USED: GA/Spinal Anaesthesia

TYPE OF FIXATION: Open reduction and internal fixation

DATE OF SURGERY:

APPROACH:

IMPLANT TYPE:

COMPLICATIONS:

- Intra-op :
- Post-op :
- Delayed :

Additional procedures:

- Revision and bone grafting :
- Debridement and irrigation :
- Others :

Follow up

- **Radiological union :**

Signature of candidate

Signature of supervisor

Follow up by Merle d'Aubigné and Postel Method

Parameters	4 weeks	3 Months	6 Months
Mobility of the hip			
Pain			
Ability to walk			

Merle d'Aubigné and Postel score at final follow up:

Signature of Candidate

Signature of Supervisor

CRITERIA FOR FUNCTIONAL EVALUATION

Merle d'Aubigné and Postel Method

Score	Pain	Mobility	Ability to walk
0	Pain is intense and permanent	Ankylosis in abnormal position	Impossible
1	Pain is severe, disturbing sleep	Ankylosis in normal position or in a very slight abnormal position	Only with crutches
2	Pain is severe when walking, prevents any activity	Flexion < 40° (abduction = 0°) or very light joint deformity.	Only with two canes
3	Pain is severe but may be tolerated with limited activity	Flexion < 40°–60°	Limited with one cane (less than one hour). Very difficult without a cane
4	Pain only after walking and disappearing with rest	Flexion > 60°–80° (can tie shoelaces)	Prolonged with one cane; limited without a cane (limp)
5	Very little pain and intermittent, does not preclude normal activity	Flexion > 80°–90°. Limited abduction (> 25°)	Without a cane but slight limp
6	No pain at all	Normal. Flexion > 90°. Abduction > 25°	Normal

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I..... .D/o, W/o, S/o..... am willing to participate in the study **"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य **"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

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गवाह के हस्ताक्षर

नाम:

_____

रोगी के हस्ताक्षर/अंगूठे का निशान

नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"CLINICAL AND RADIOLOGICAL OUTCOMES IN SURGICALLY MANAGED PATIENTS OF TRANSVERSE FRACTURES OF ACETABULUM" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੈਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ

_____
ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____

ਮਿਤੀ_____

ਪਤਾ _____

ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ